"What is a Forest Ecologist Doing Working for NASA? - **The Use of NASA Technology and Models to Study Land Surface Abiotic and Biotic Processes "**

Jeffrey C. Luvall
NASA
Marshall Space Flight Center

ESES Graduate Summer Bridge Program
CCNY

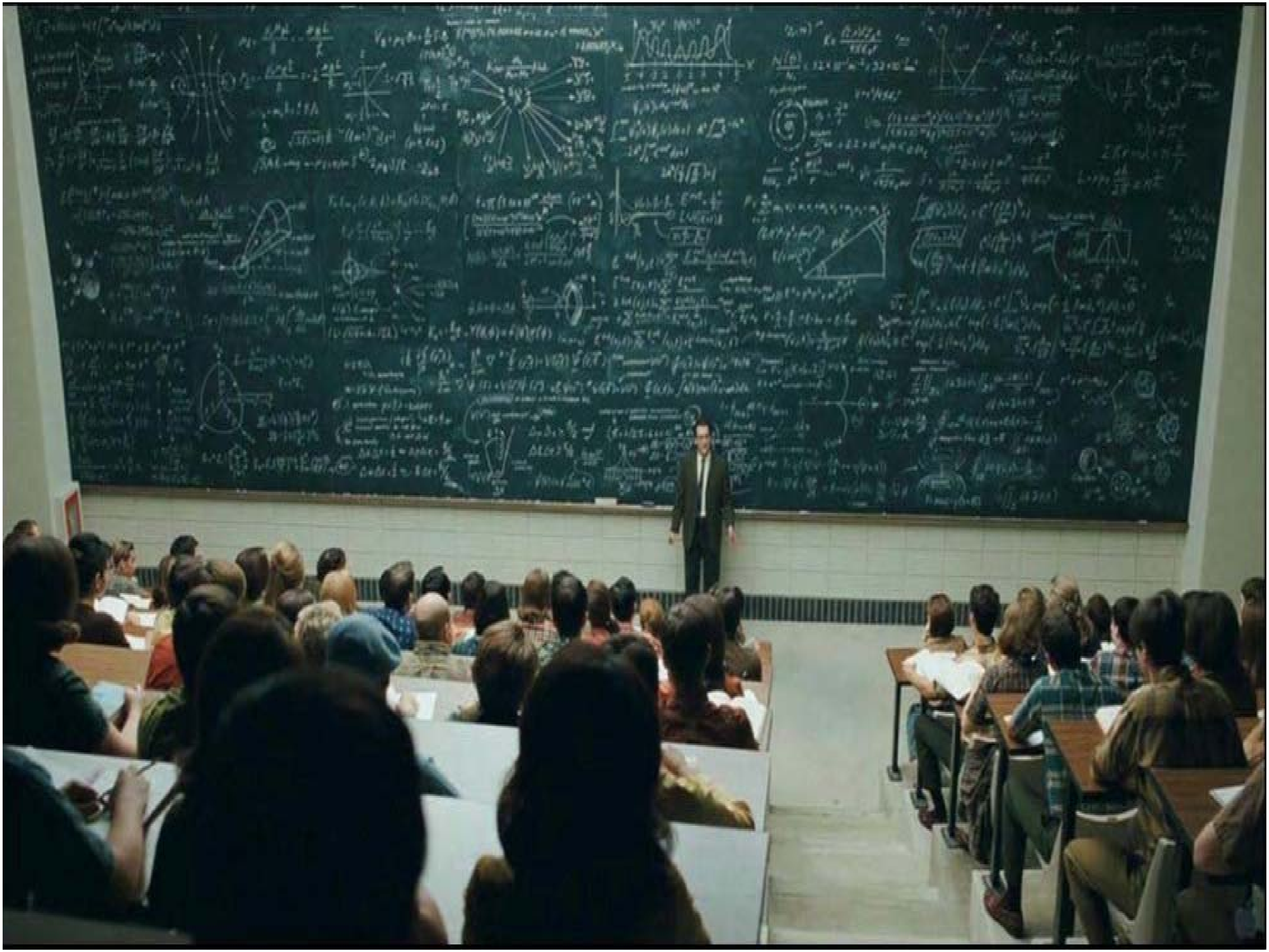


Figure 3-4 Photograph of Gaspard Felix Tournachon (1820-1910), the famous Parisian photographer. He called himself Nadar. Here he is seen kneeling in a fragile balloon gondola. He obtained the first aerial photograph from a balloon in 1858 near Paris, France, and patented the aerial survey as we know it today. Unfortunately, the first aerial photograph did not survive (© Roger-Viollet, Paris, France; used with permission).

Figure 3-5 A portion of an aerial photograph of downtown Boston, MA, obtained by aeronauts James W. Black and Samuel A. King from a tethered balloon at an altitude of 1,200 ft on October 13, 1860. It is believed to be the first aerial photograph taken from a captive balloon in the United States and the earliest aerial photograph still in existence. It was obtained using a wet collodion plate (used with permission of the Smithsonian Institution, Washington, DC; #3B-15472).

Sensors Considerations

1. Spectral sensitivity of the sensors available.

2. Presence or absence of atmospheric windows in the spectral ranges in which one wants to sense.

3. The source, magnitude, and spectral composition of the energy available in these ranges.

Landsat Satellite Series

Landsat 1: Launched 7/23/72; Deactivated 1/6/78

Landsat 2: Launched 1/22/75; Deactivated 2/25/82

Landsat 3: Launched 3/5/78; Deactivated 3/31/83

Landsat 4: Launched 7/16/82 (no longer collecting data; not yet deactivated)

Landsat 5: Launched 3/1/84

Landsat 6: Launched 10/5/93 (failed to achieve orbit)

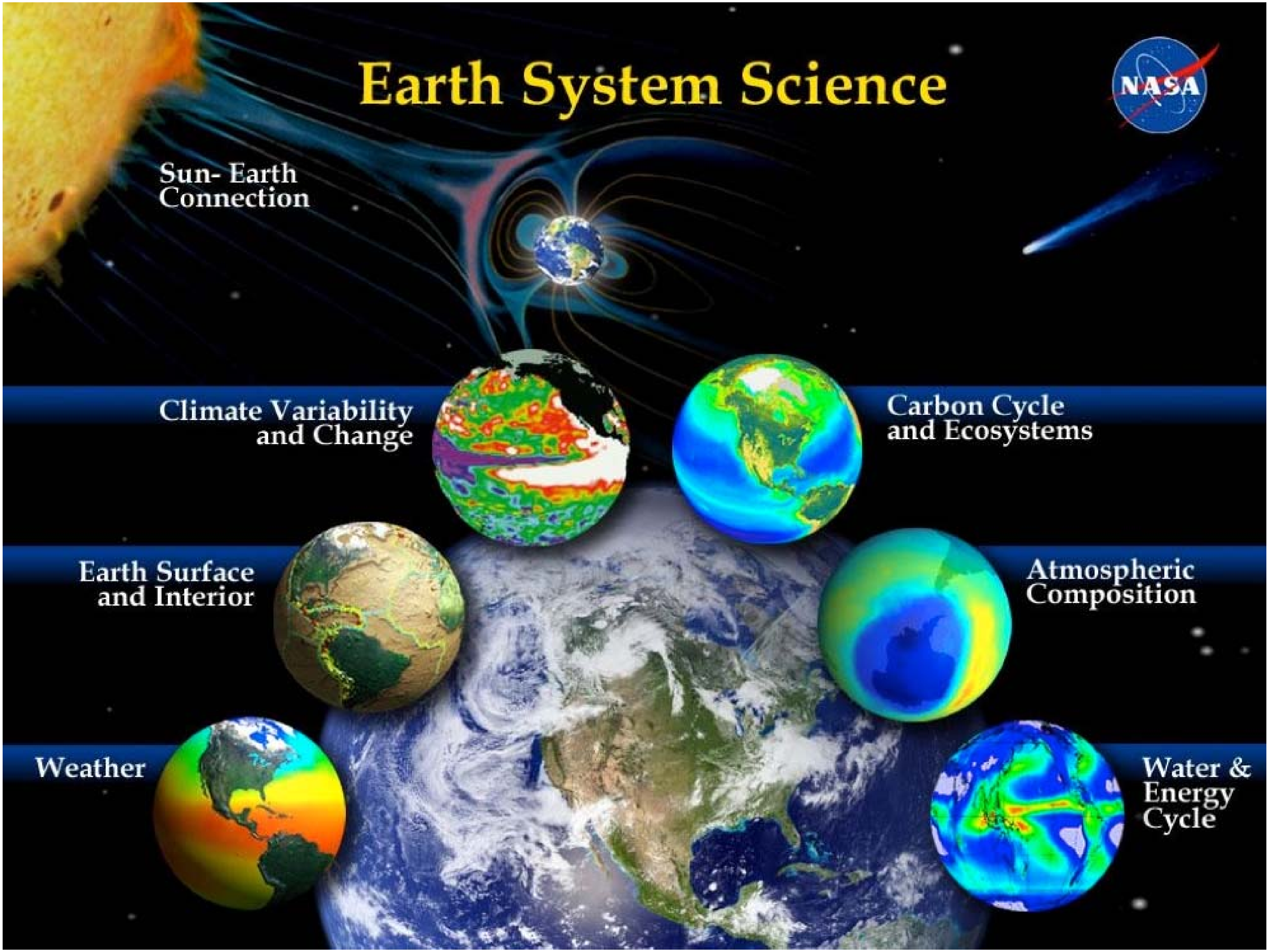
Landsat 7: Launched 4/15/99

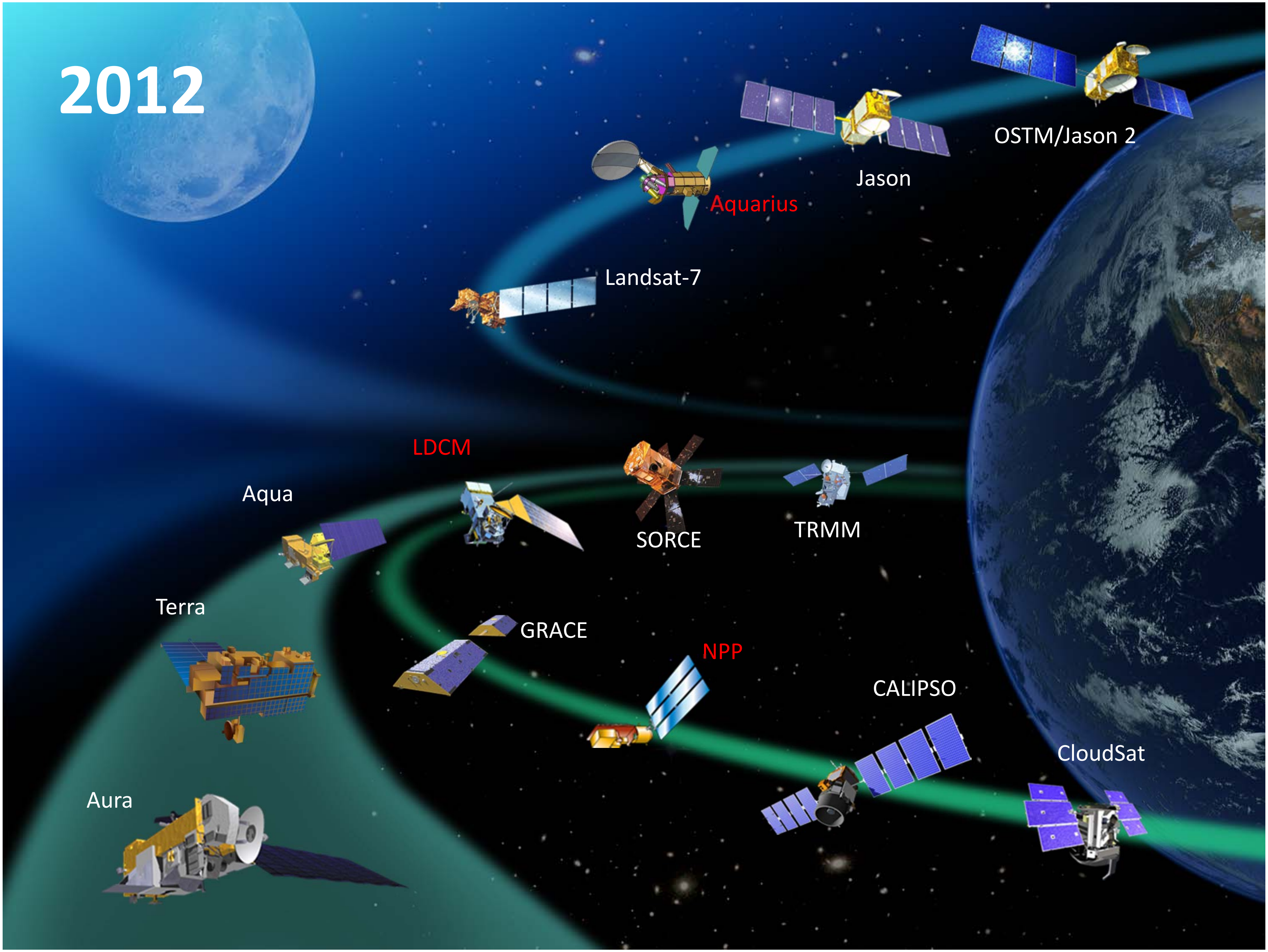
2010 NASA Science Plan

The 2010 Science Plan identifies the direction NASA has received from the Administration and Congress, advice received from the nation's science community, principles and strategies guiding the conduct of our activities, and challenges we face. The plan that results enables NASA, as Administrator Bolden says, to "do the best science, not just more science."

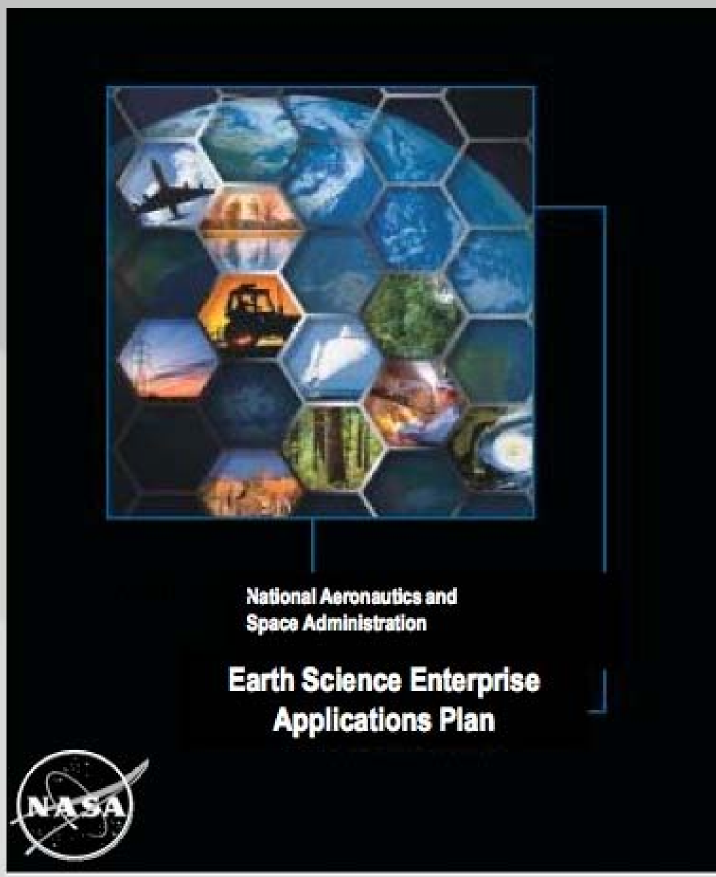
The NASA Earth Science strategic goal is stated as, ***"Advance Earth System Science to meet the challenges of climate and environmental change."***

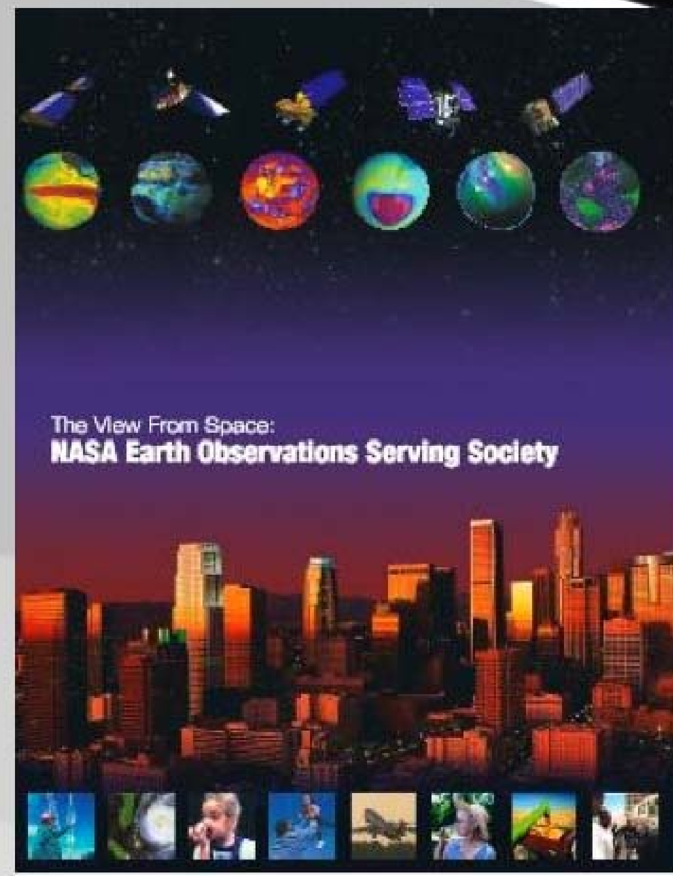
http://science.nasa.gov/media/medialibrary/2010/08/30/2010SciencePlan_TAGGED.pdf


Earth System Science
NASA
Sun- Earth Connection
Climate Variability and Change
Carbon Cycle and Ecosystems
Earth Surface and Interior
Atmospheric Composition
Weather
Water & Energy Cycle


2012
OSTM/Jason 2
Jason
Aquarius
Landsat-7
LDCM
Aqua
SORCE
TRMM
Terra
GRACE
NPP
CALIPSO
CloudSat
Aura

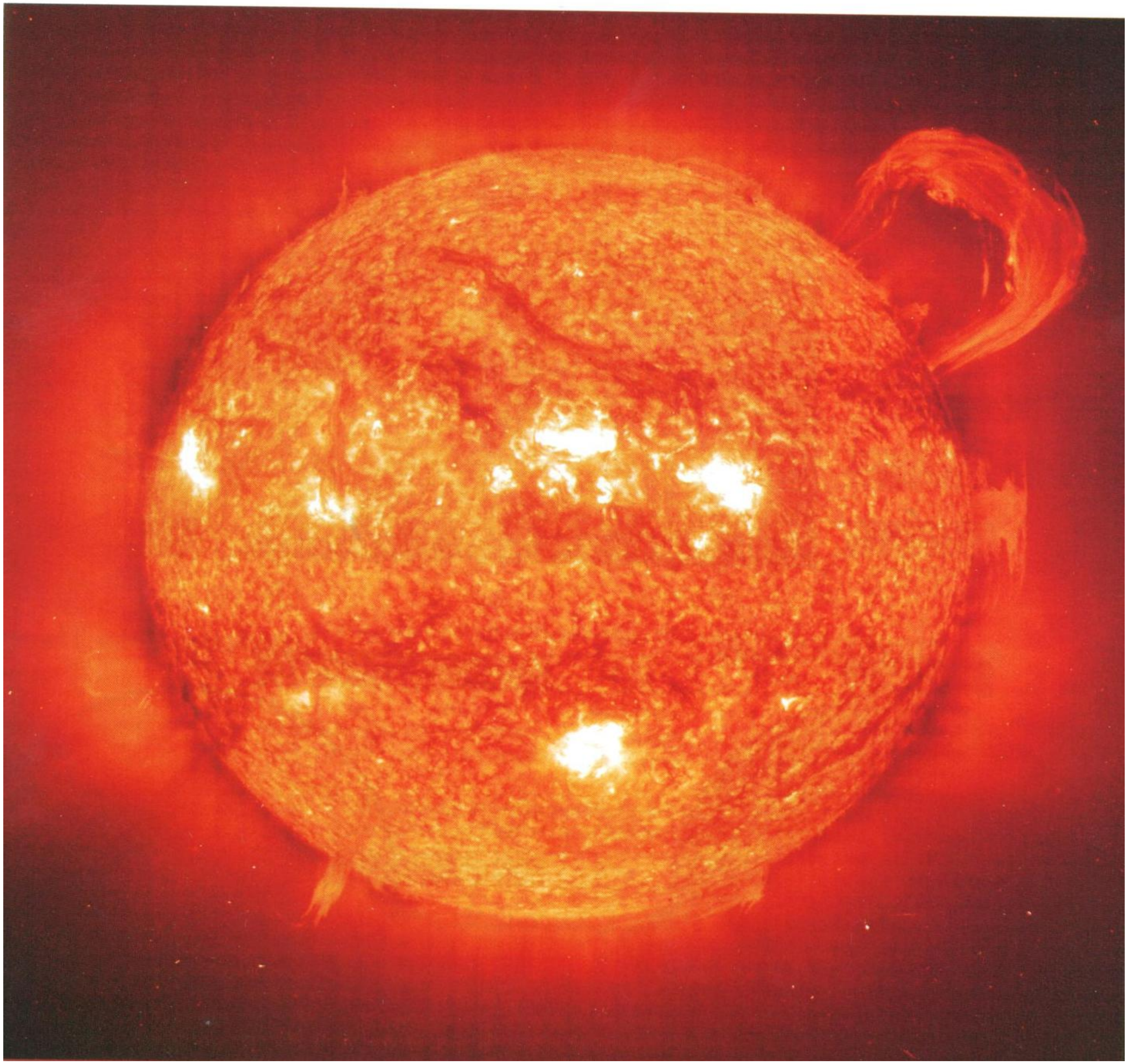
Applied Sciences Program





http://nasascience.nasa.gov/earth-science/applied-sciences

Solar and Heliospheric Observatory (SOHO) EIT Image
of the Sun Obtained on September 14, 1999



What Happens to the Sun's Energy ?

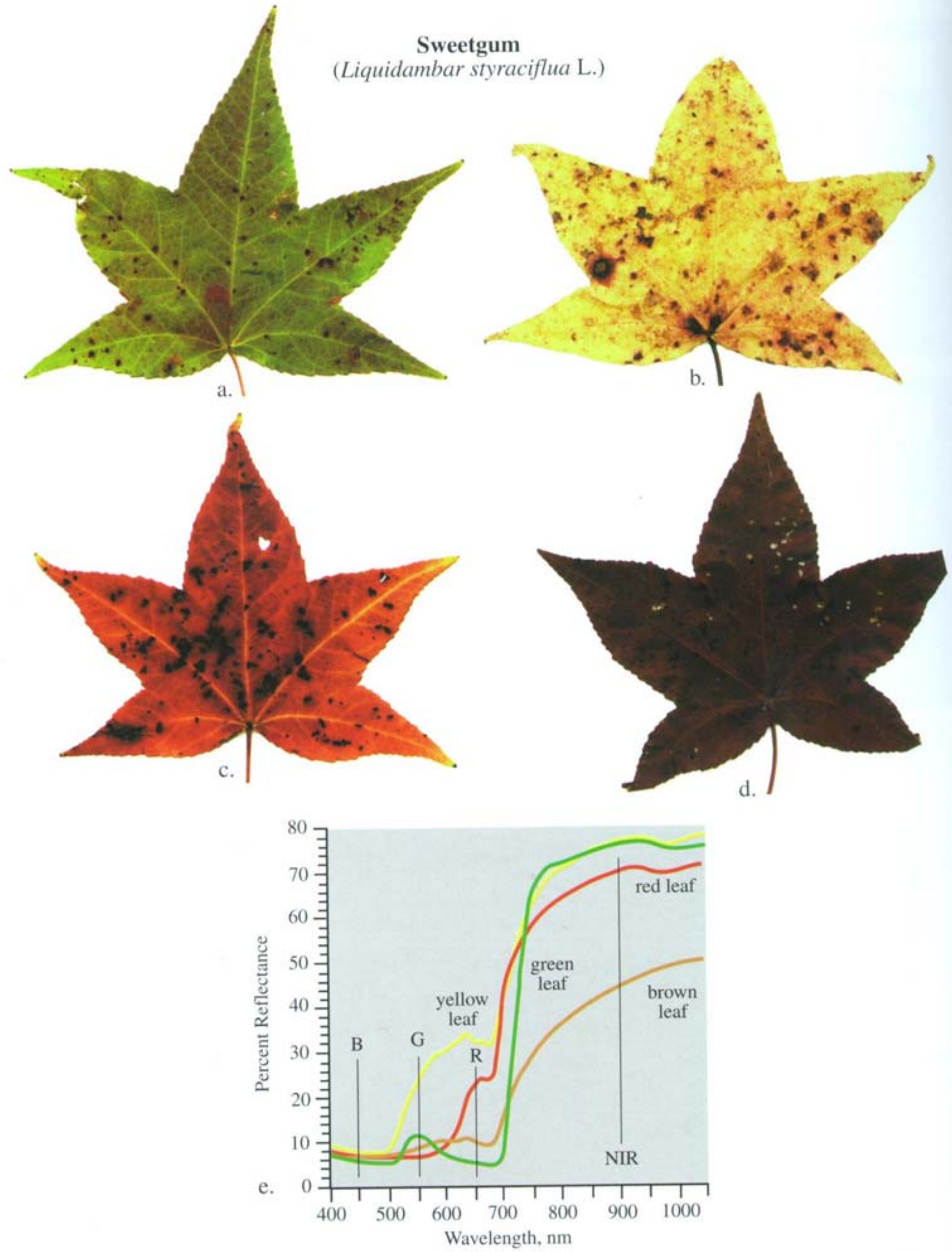
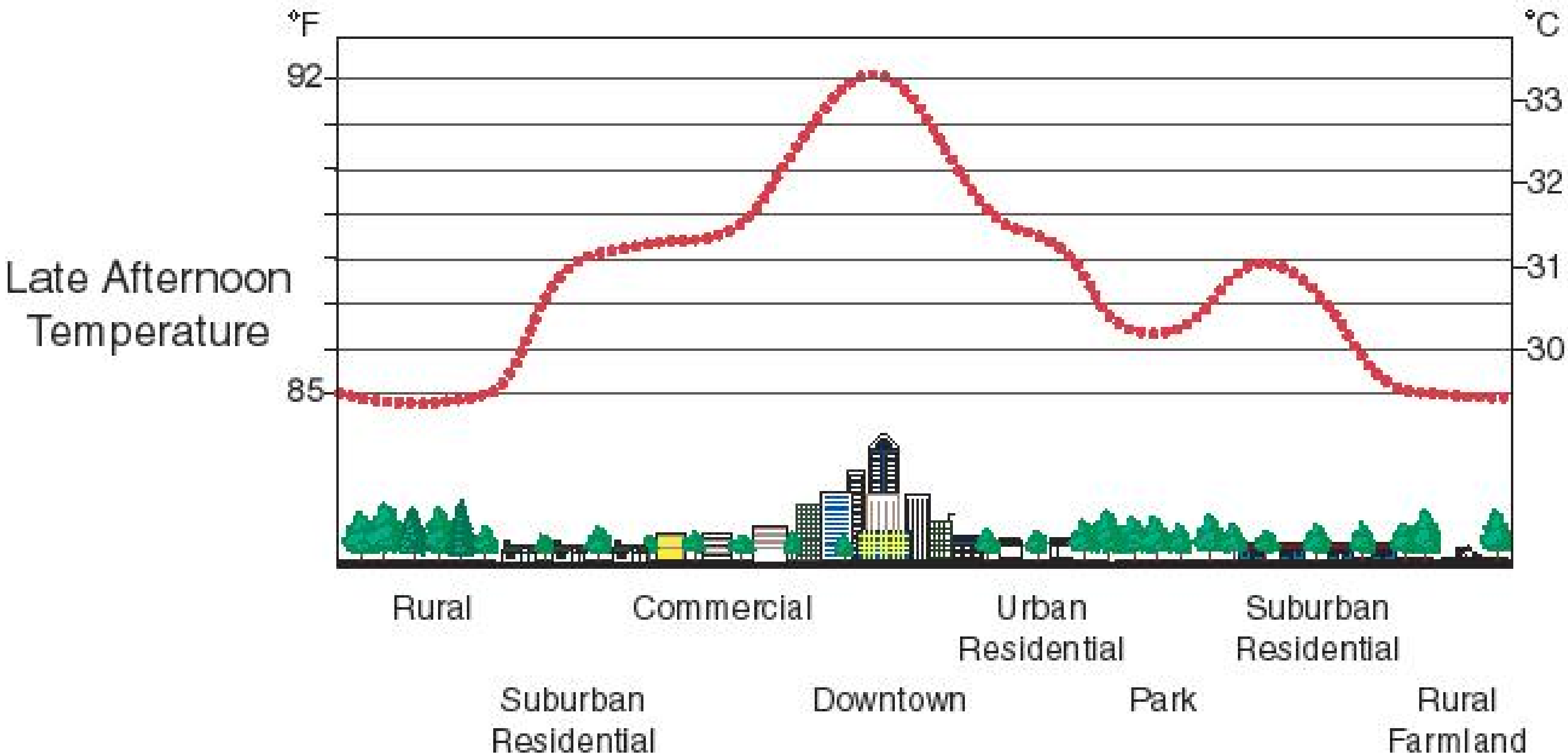


Plate 10-1 a) Photosynthesizing green Sweetgum leaf (*Liquidambar styraciflua* L.) obtained from a tree on November 11, 1998. b-c) Senescing yellow and red Sweetgum leaves obtained from the tree. d) Senesced Sweetgum leaf that was on the ground. e) Geophysical & Environmental Research, Inc. (GER) 1500 spectroradiometer percent reflectance measurements over the wavelength interval 400 – 1050 nm.

Sketch of an Urban Heat-Island Profile



Surface Radiation Budget

$$Q^* = (K_{in} + K_{out}) + (L_{in} + L_{out})$$

Q^* = Net Radiation

K_{in} = Incoming Solar

K_{out} = Reflected Solar

L_{in} = Incoming Longwave

L_{out} = Emitted Longwave

Surface Energy Budget

$$Q^* = H + LE + G$$

H = Sensible Heat Flux

LE = Latent Heat Flux

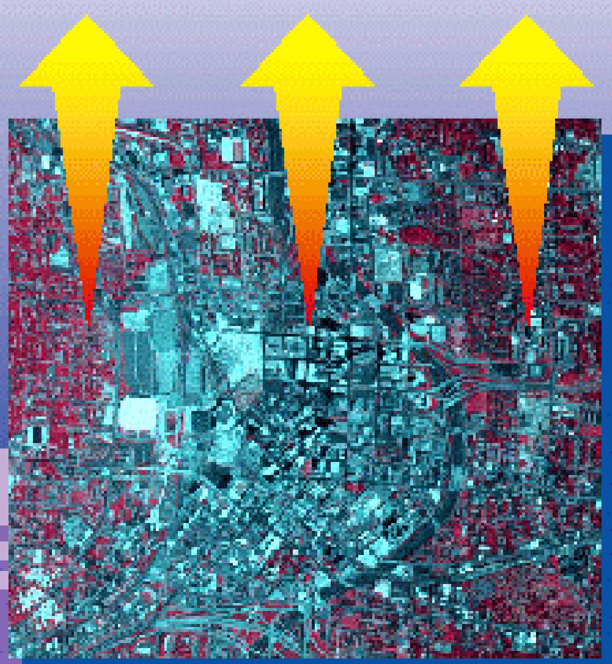
G = Storage (maybe + or -)

Mission to Planet Earth
National Aeronautics and Space Administration

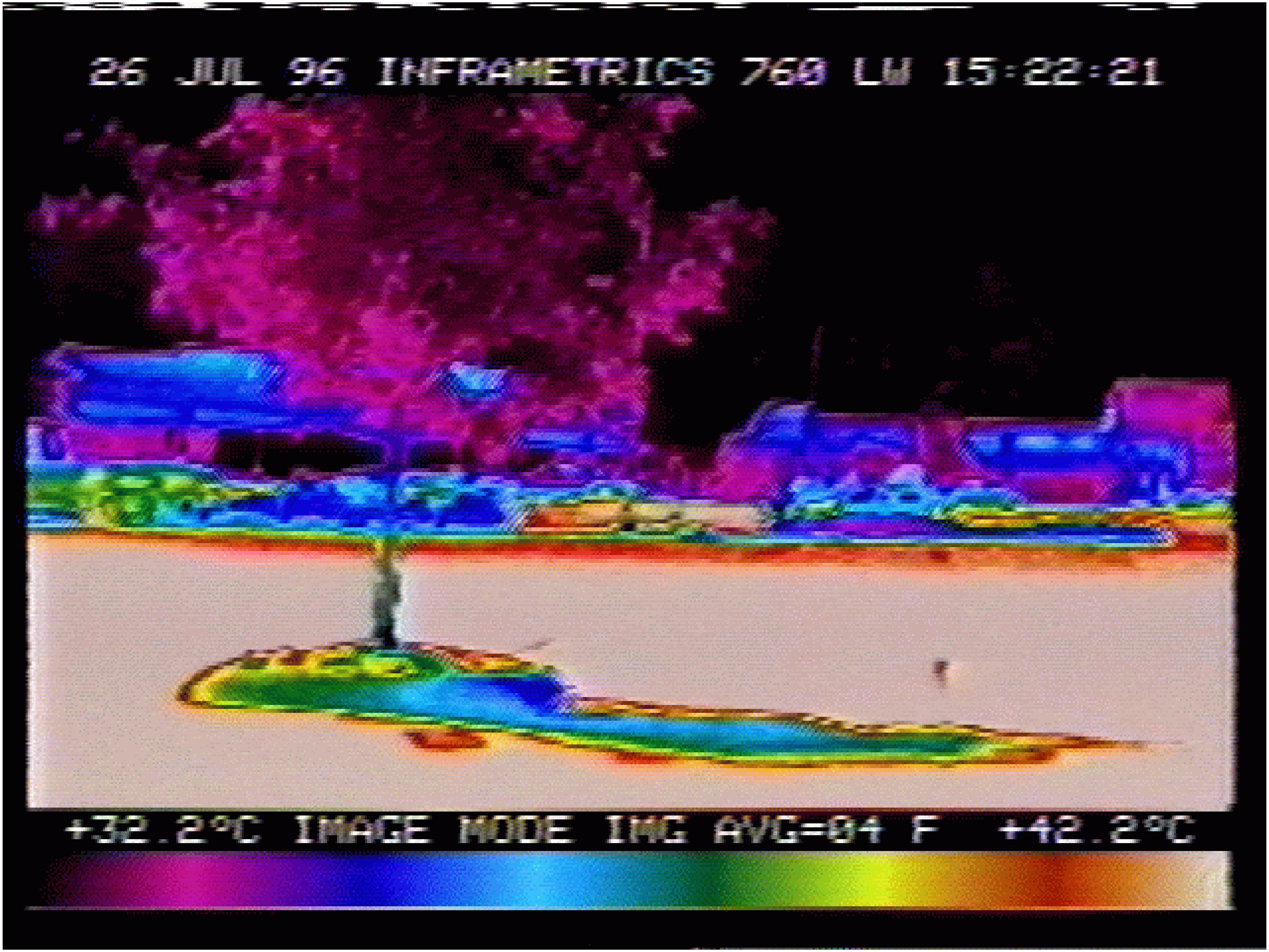
Urban Remote Sensing and Air Quality Models

Volatile Organic Compounds
+ Nitrogen Oxides
+ Sunlight

→ Ozone



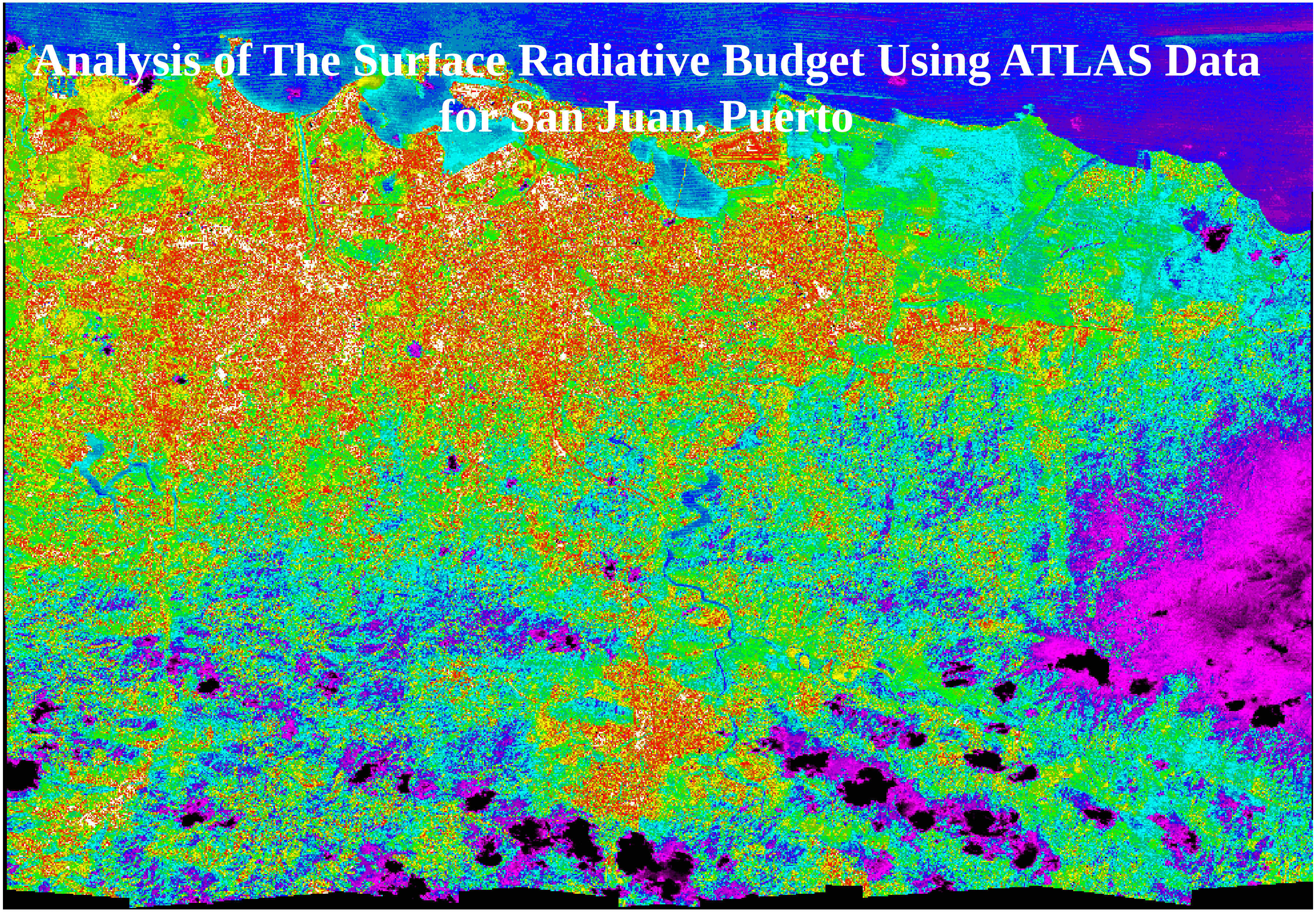
- Air pollution remains a National issue.
- Temperature increases the ozone levels.
- Urban heat island has major effect on temperature and height of mixing layer.
- Measurement program is defining land use patterns and relationship to heat production.
- Remote sensing data are being used to improve air quality modeling.


26 JUL 96 INFRAMETRICS 760 LW 15:22:21
+32.2°C IMAGE MODE IMG AVG=04 F +42.2°C

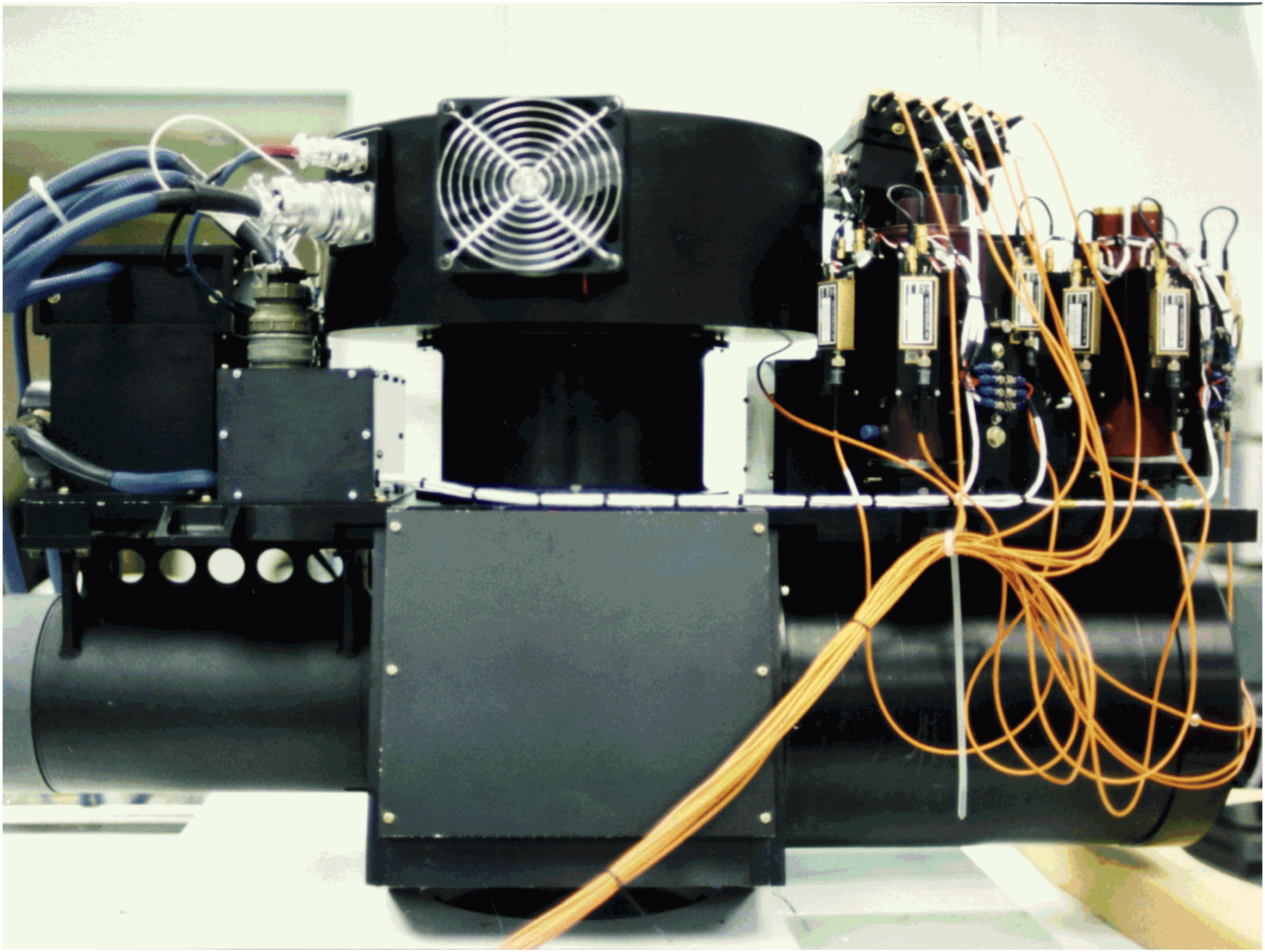
Urban Heat Island Mitigation Strategies

- Albedo Modification
  - Lighter colored roofs and pavements
  - New materials/coatings
- Plant trees and increase green space
  - Shade buildings, rooftops, parking lots and roads
  - Cool the air through transpiration
- Rooftop gardens
  - Keep roofs cool by shading and/or transpiration
  - storm water reduction

Analysis of The Surface Radiative Budget Using ATLAS Data for San Juan, Puerto



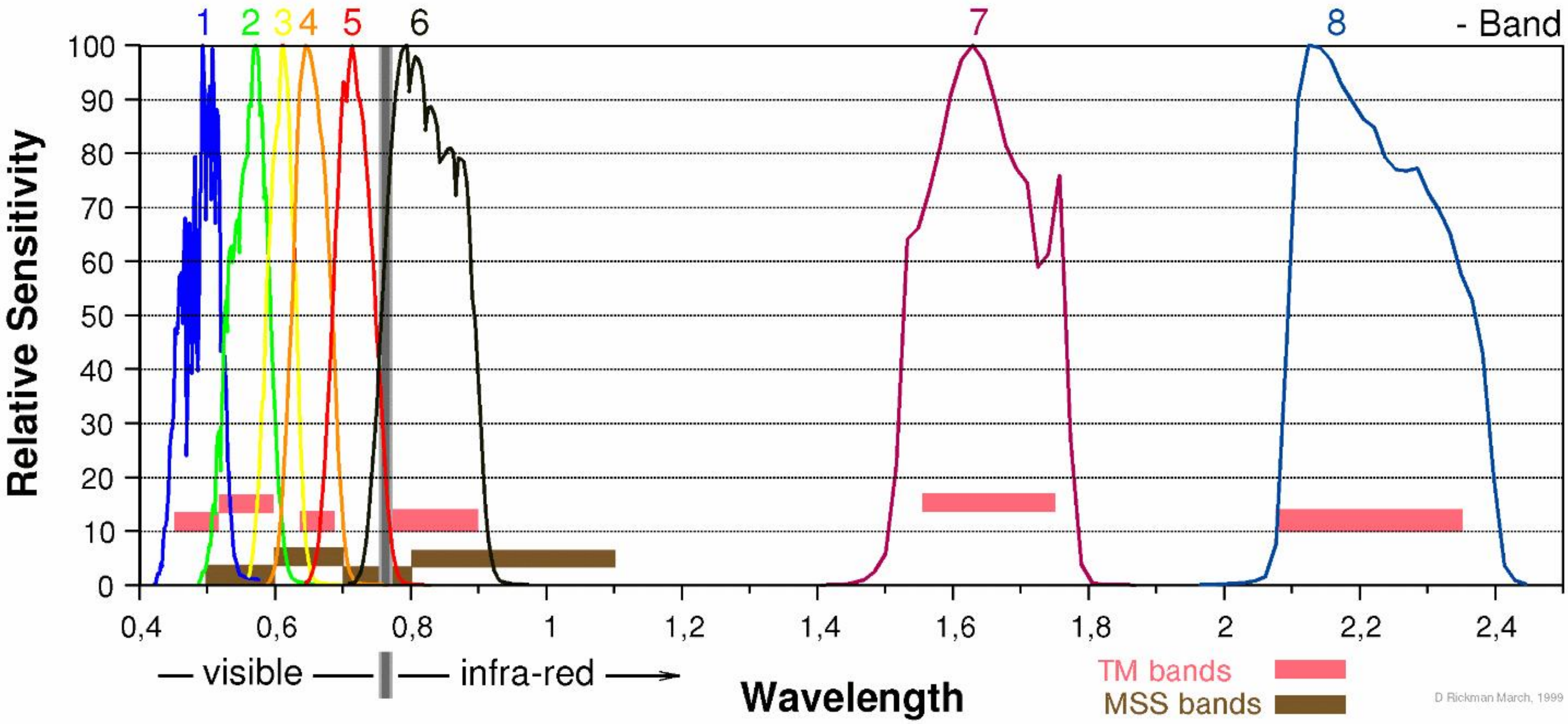

NASA
N933NA



ATLAS

Typical Spectral Response Curves

Reflected Bands

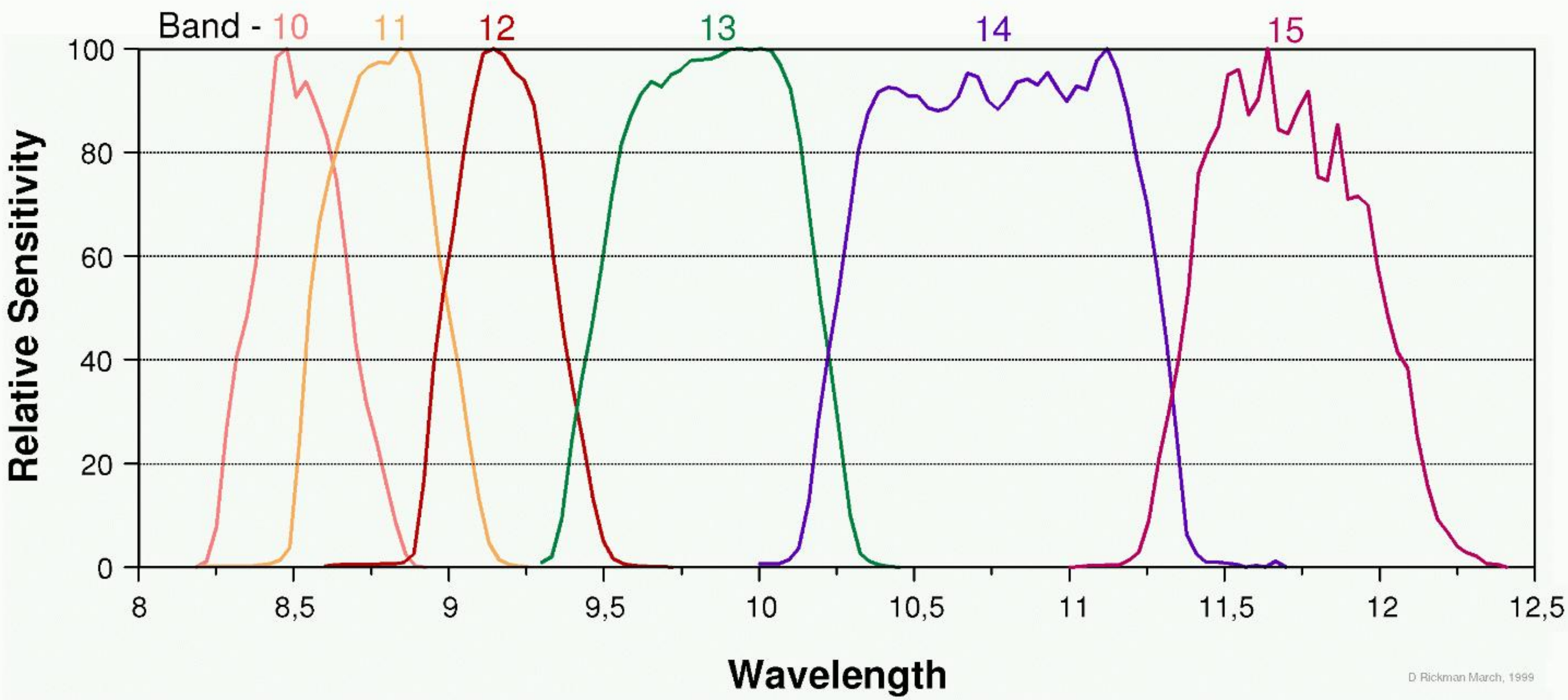


D. Rickman, et al., Nov. 9,1999

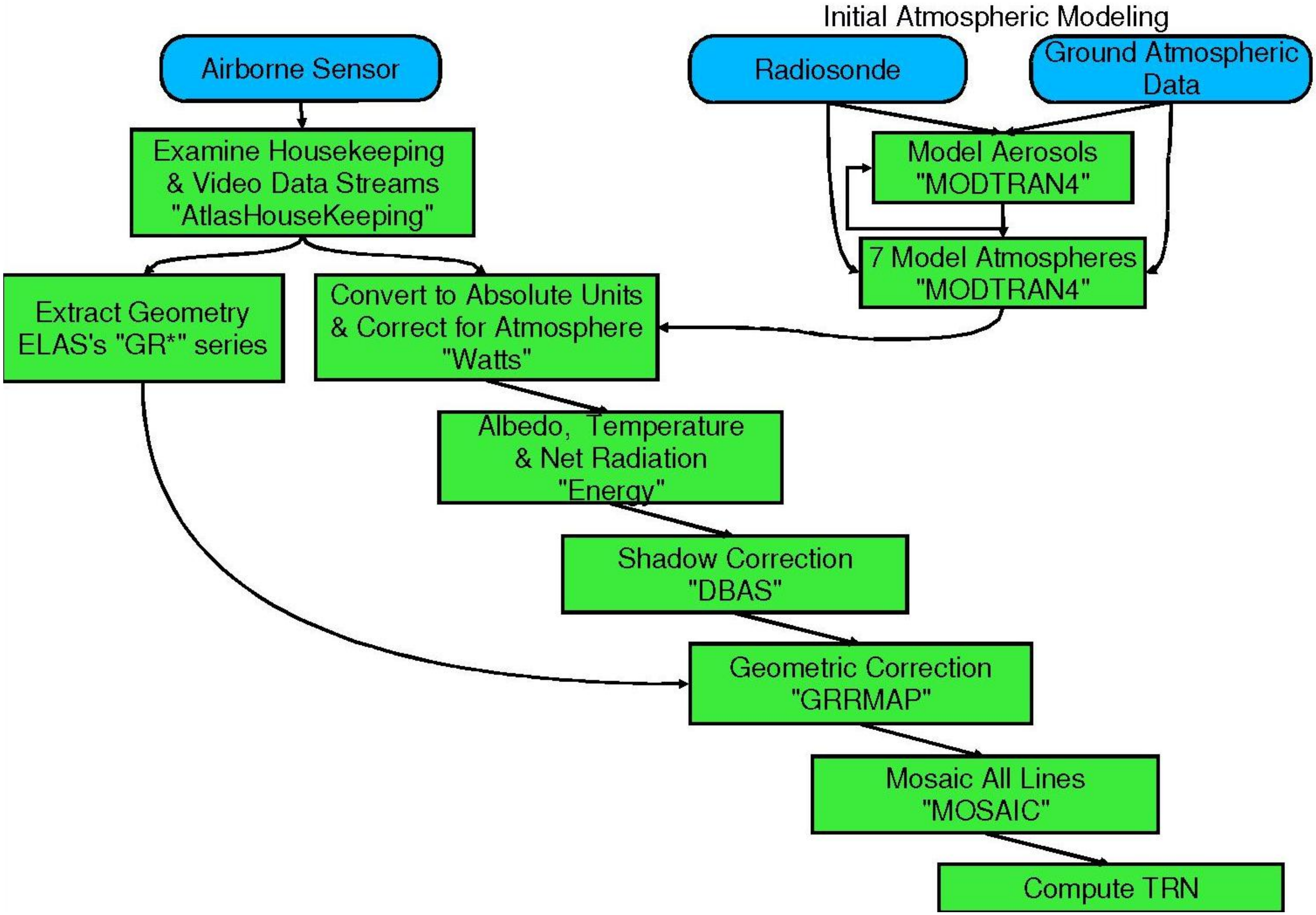
ATLAS

Typical Spectral Response Curves

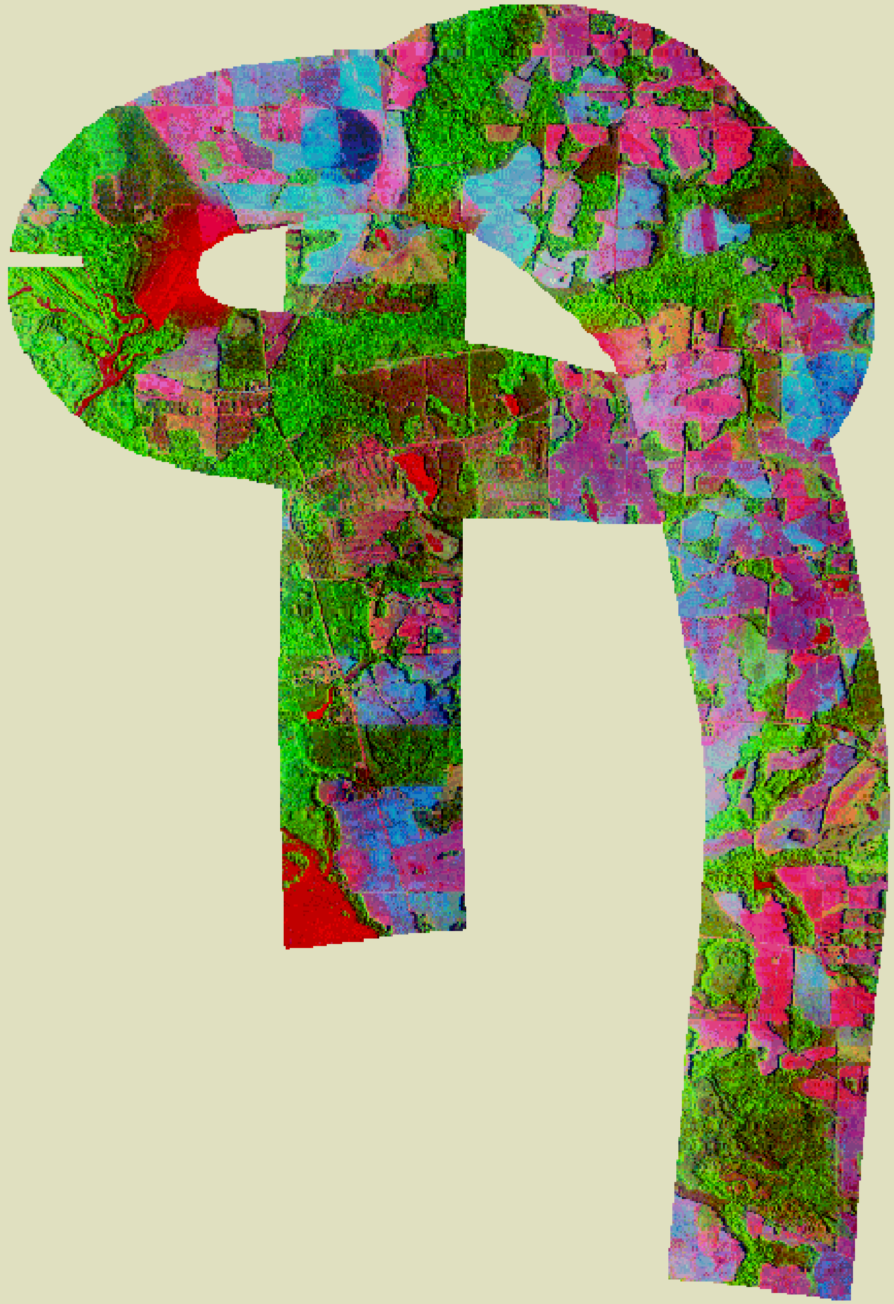
Thermal Bands



D. Rickman, et al., Nov. 9,1999


Initial Atmospheric Modeling
Airborne Sensor
Radiosonde
Ground Atmospheric Data
Examine Housekeeping & Video Data Streams "AtlasHouseKeeping"
Model Aerosols "MODTRAN4"
7 Model Atmospheres "MODTRAN4"
Extract Geometry ELAS's "GR*" series
Convert to Absolute Units & Correct for Atmosphere "Watts"
Albedo, Temperature & Net Radiation "Energy"
Shadow Correction "DBAS"
Geometric Correction "GRRMAP"
Mosaic All Lines "MOSAIC"
Compute TRN

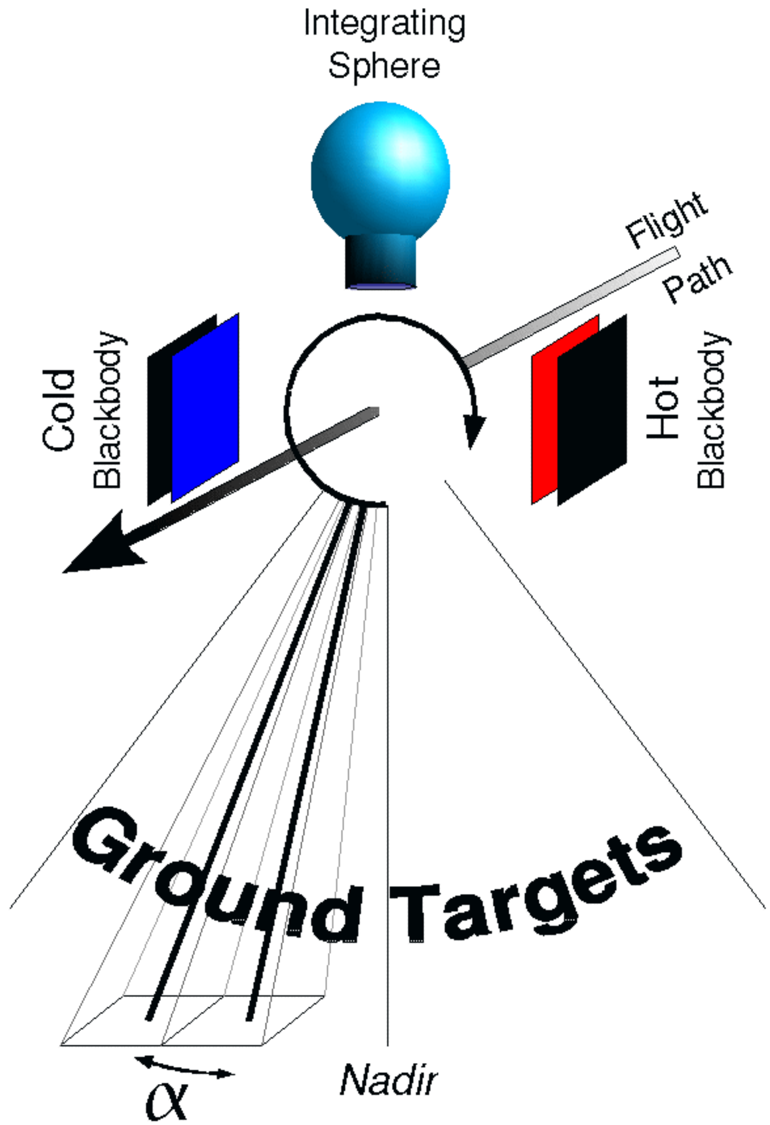
"Doug" Gordian Knot



1. An intricate knot tied by King Gordius of Phrygia and cut by Alexander the Great.

2. An exceedingly complicated problem or deadlock.

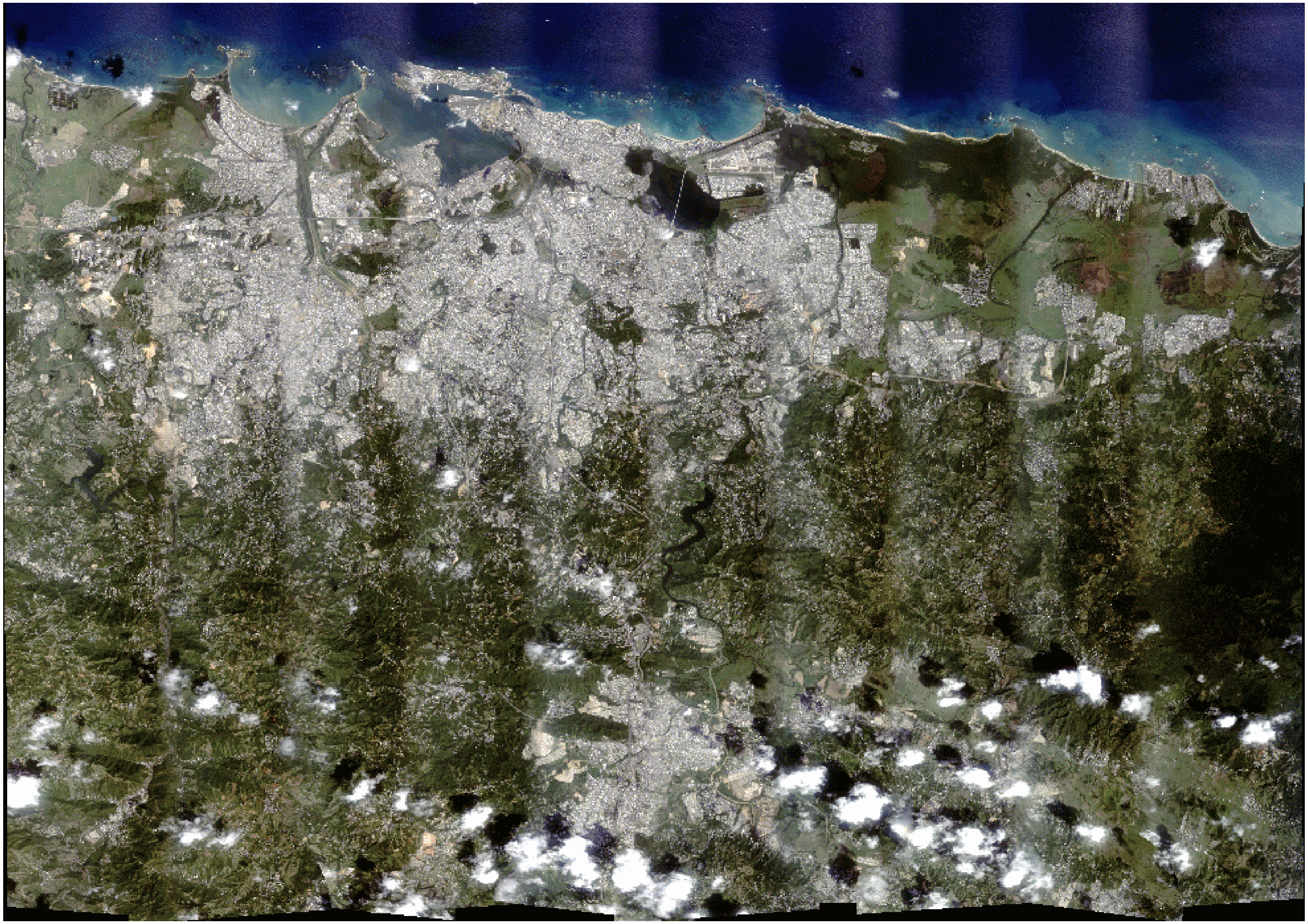
3. To solvc a problcm by rcsorting to prompt and bold mcasurcs.



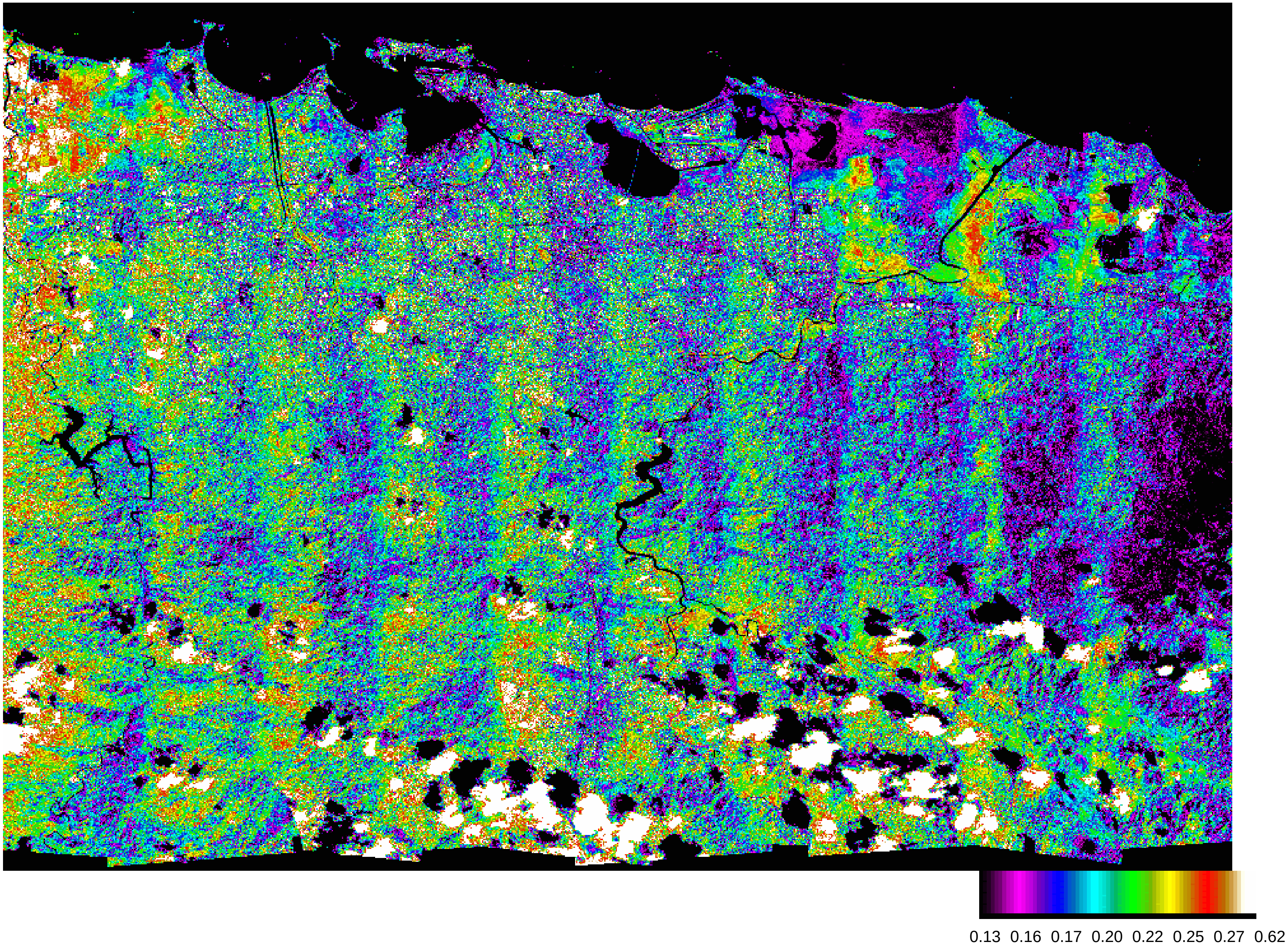
Integrating Sphere
Flight Path
Cold Blackbody
Hot Blackbody
Ground Targets
α
Nadir


YES
ENVIRONMENTAL SYSTEMS, INC.

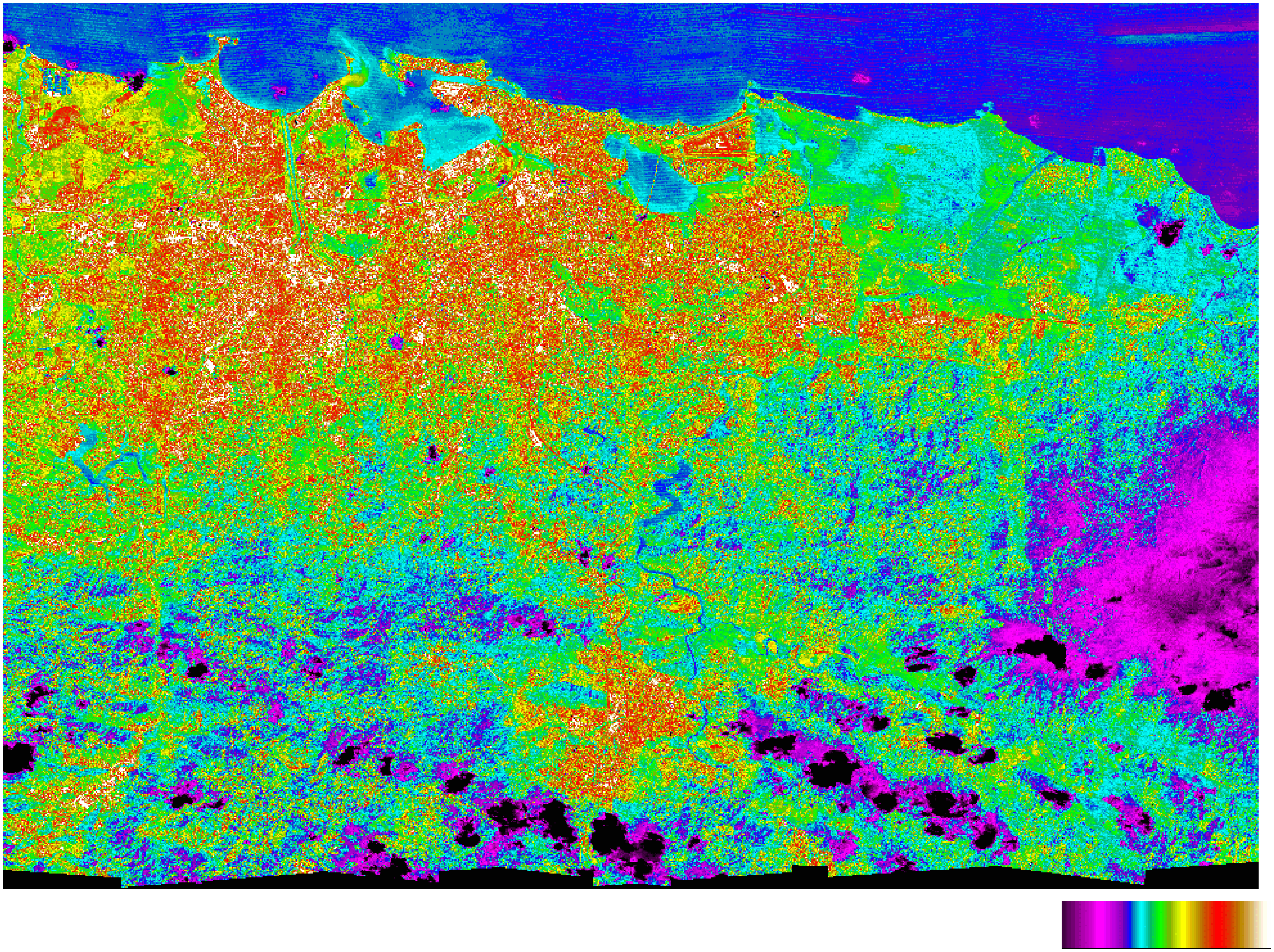
San Juan F5 Mosaic True Color

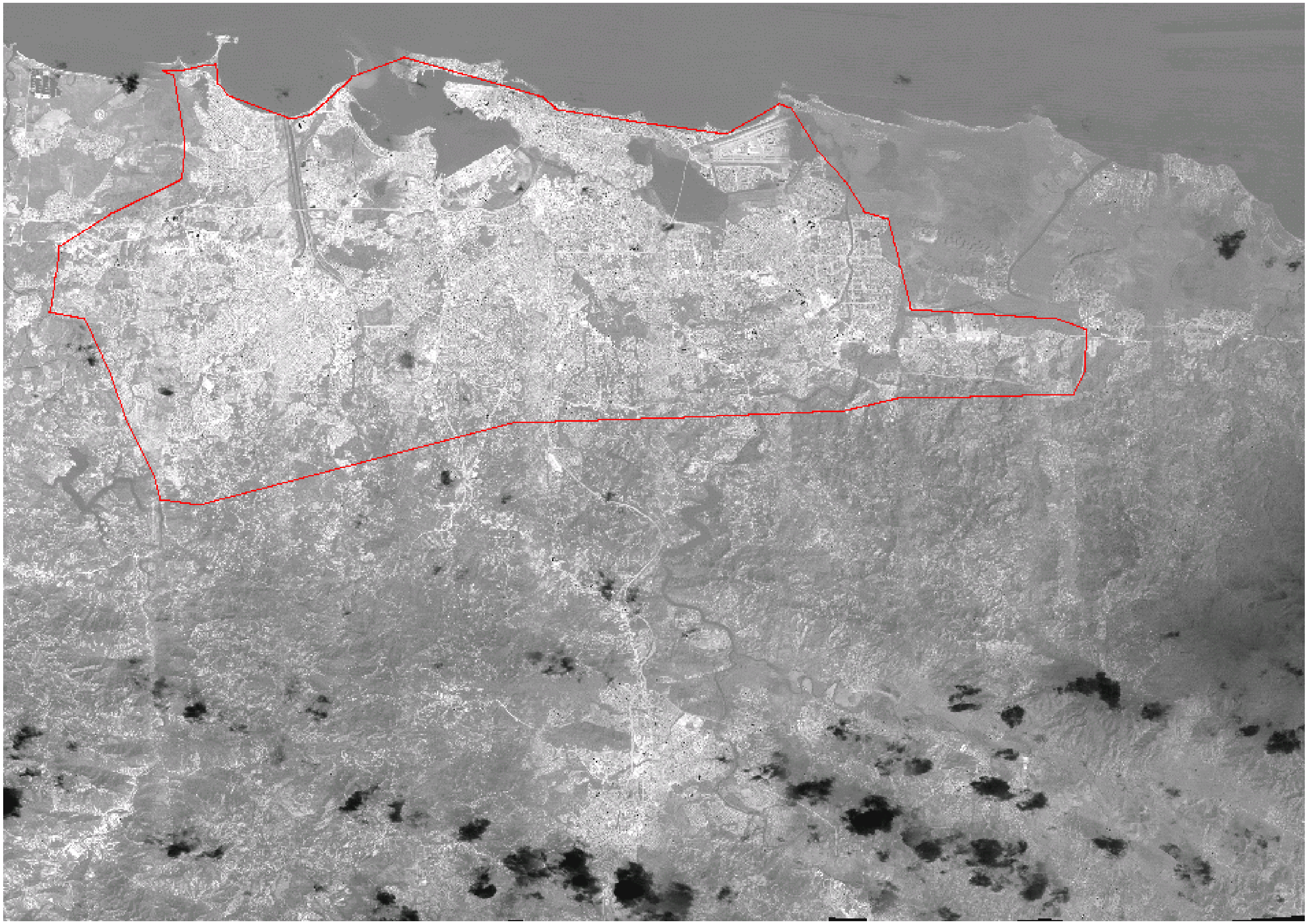


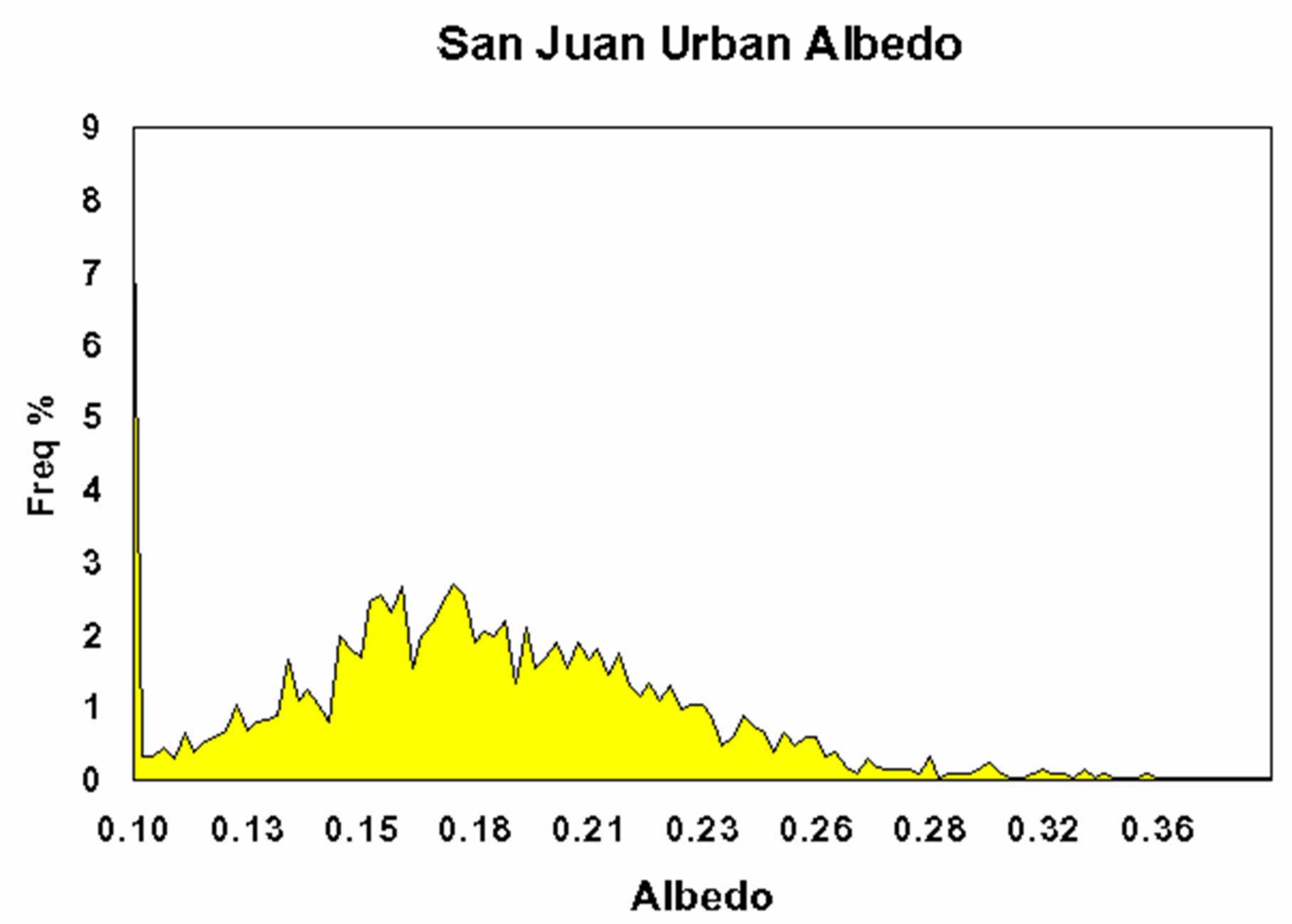
San Juan F5 Mosaic Albedo

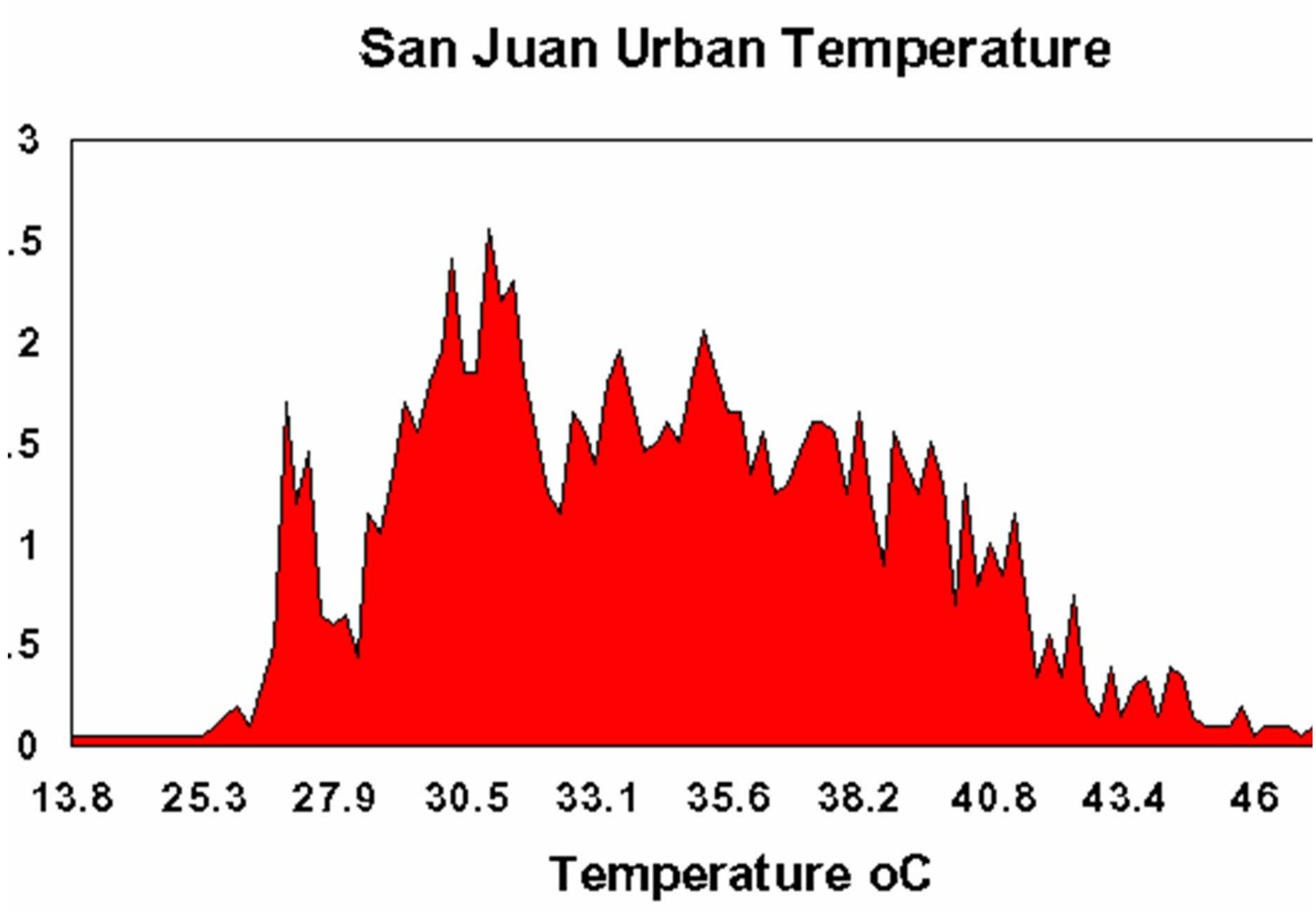


San Juan F5 Mosaic Temperature

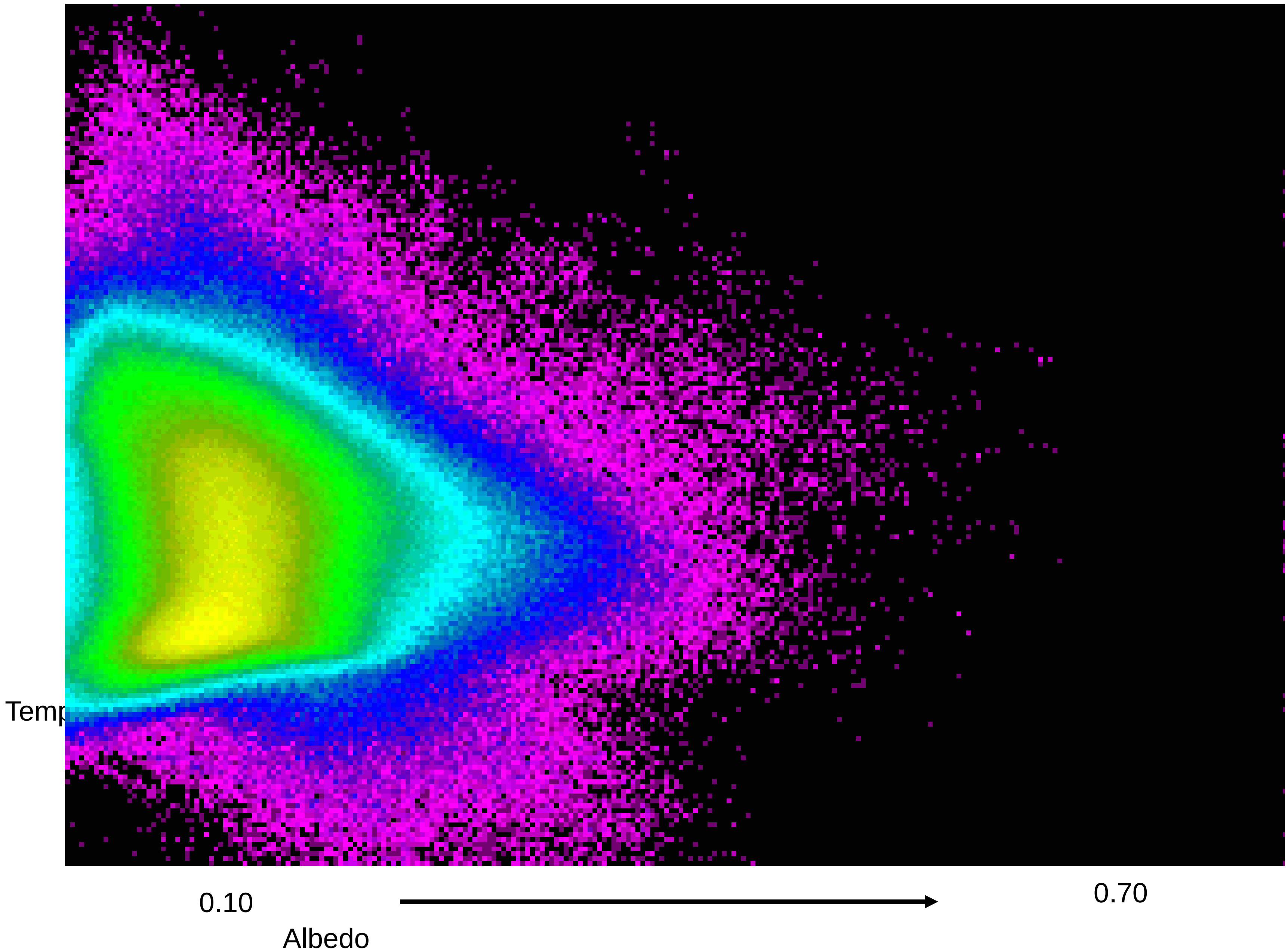


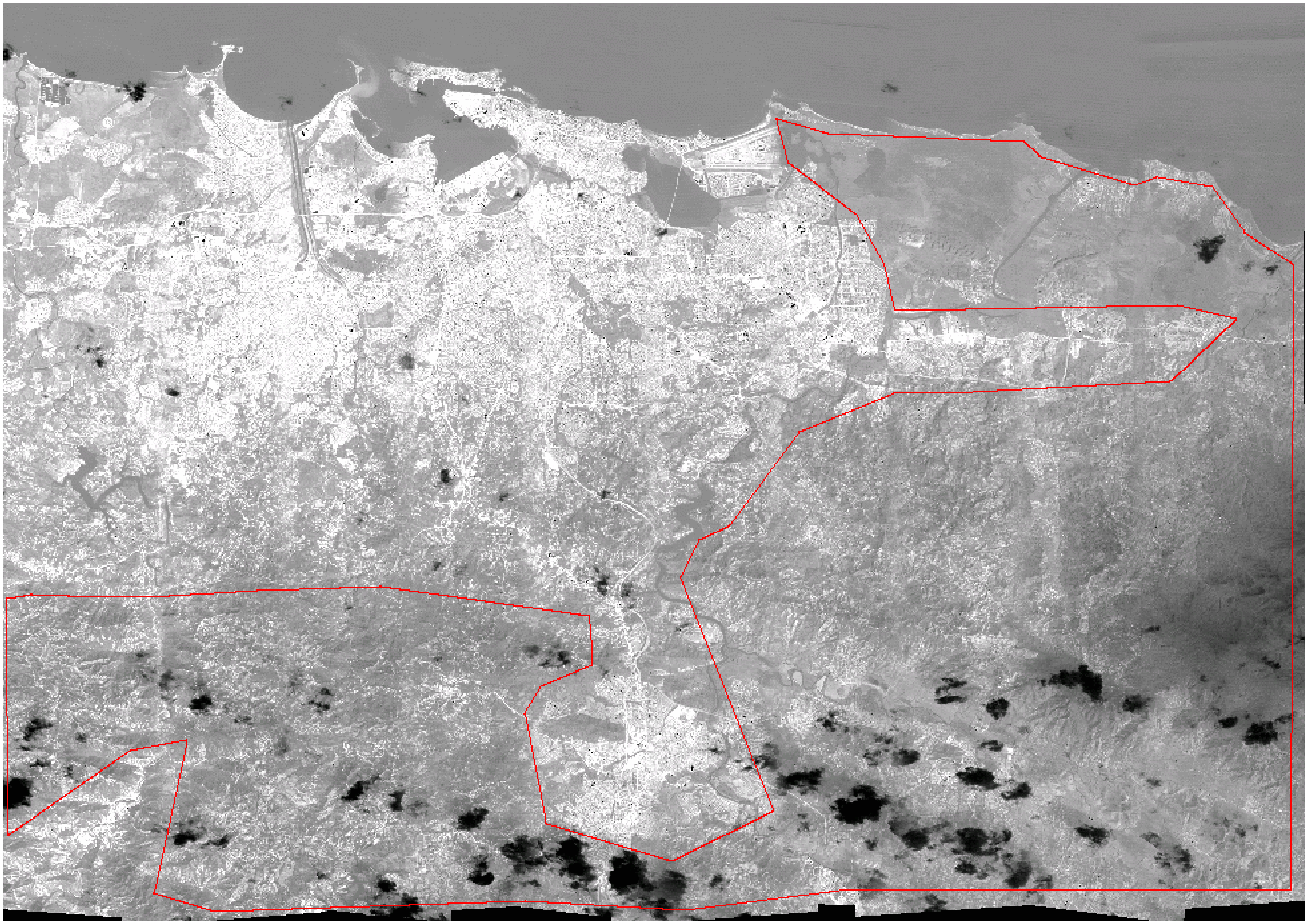


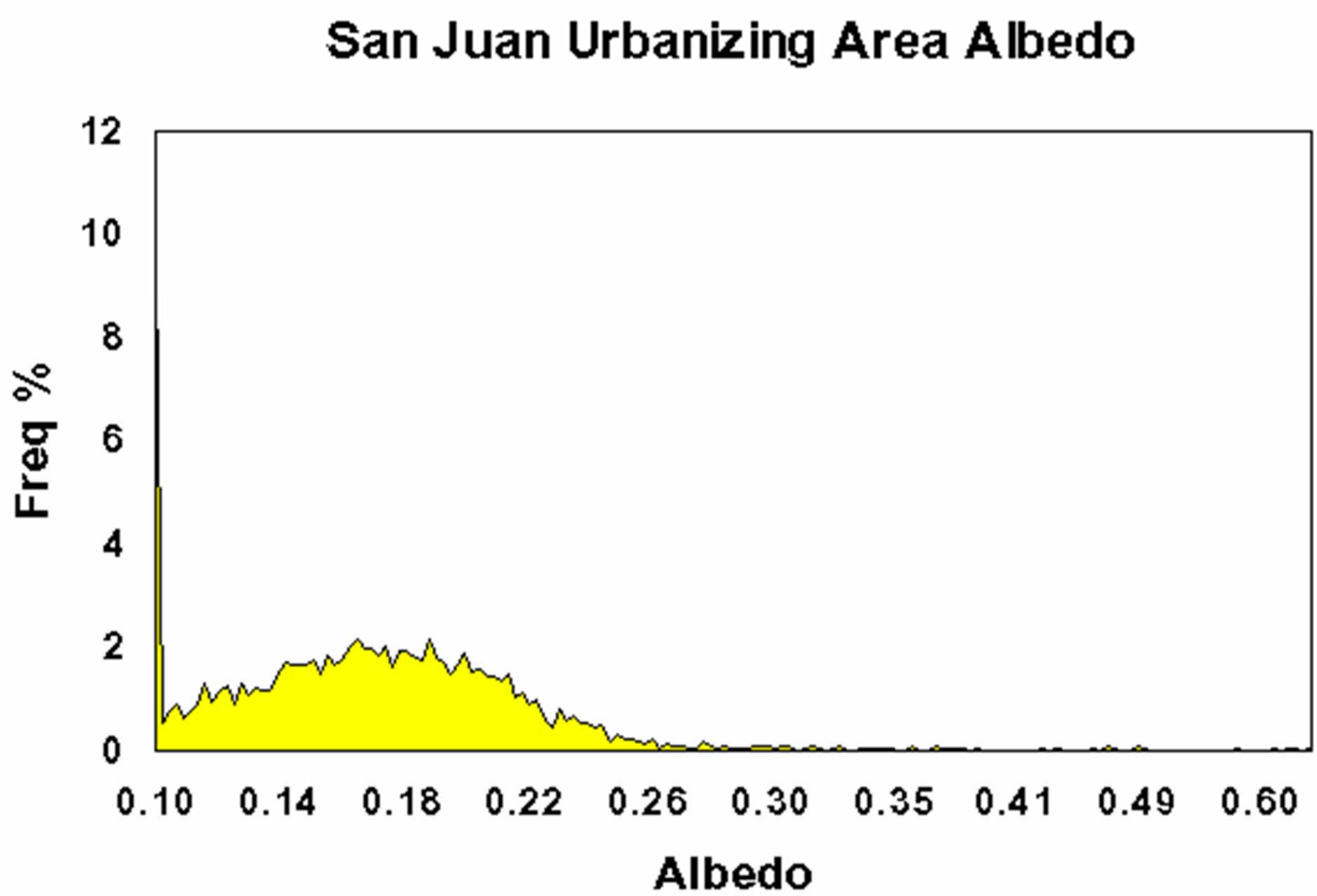

San Juan Urban Albedo
Freq %
9
8
7
6
5
4
3
2
1
0
0.10
0.13
0.15
0.18
0.21
0.23
0.26
0.28
0.32
0.36
Albedo

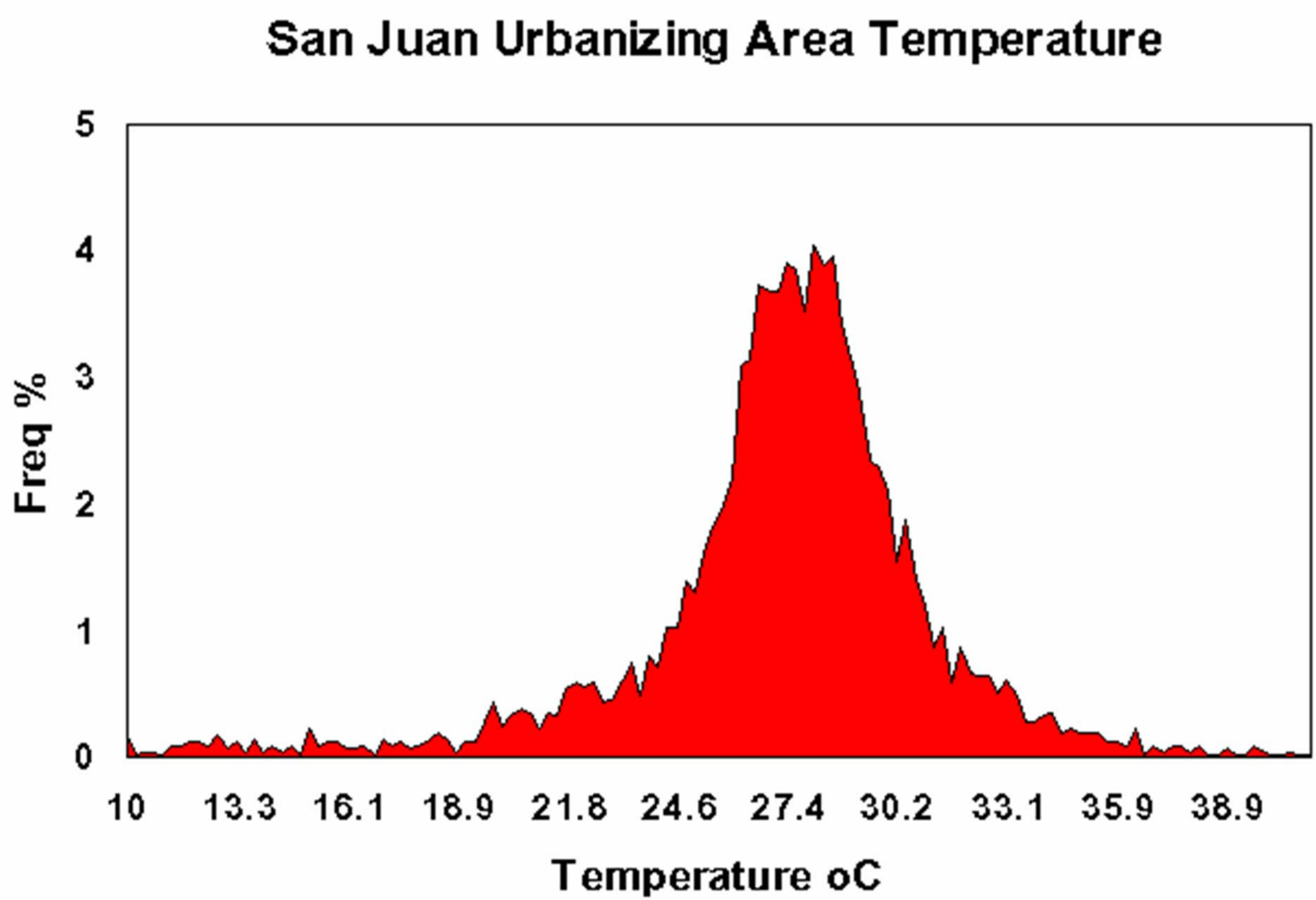

San Juan Urban Temperature
3
.5
2
.5
1
.5
0
13.8
25.3
27.9
30.5
33.1
35.6
38.2
40.8
43.4
46
Temperature oC

San Juan Puerto Rico
Albedo vs Temperature

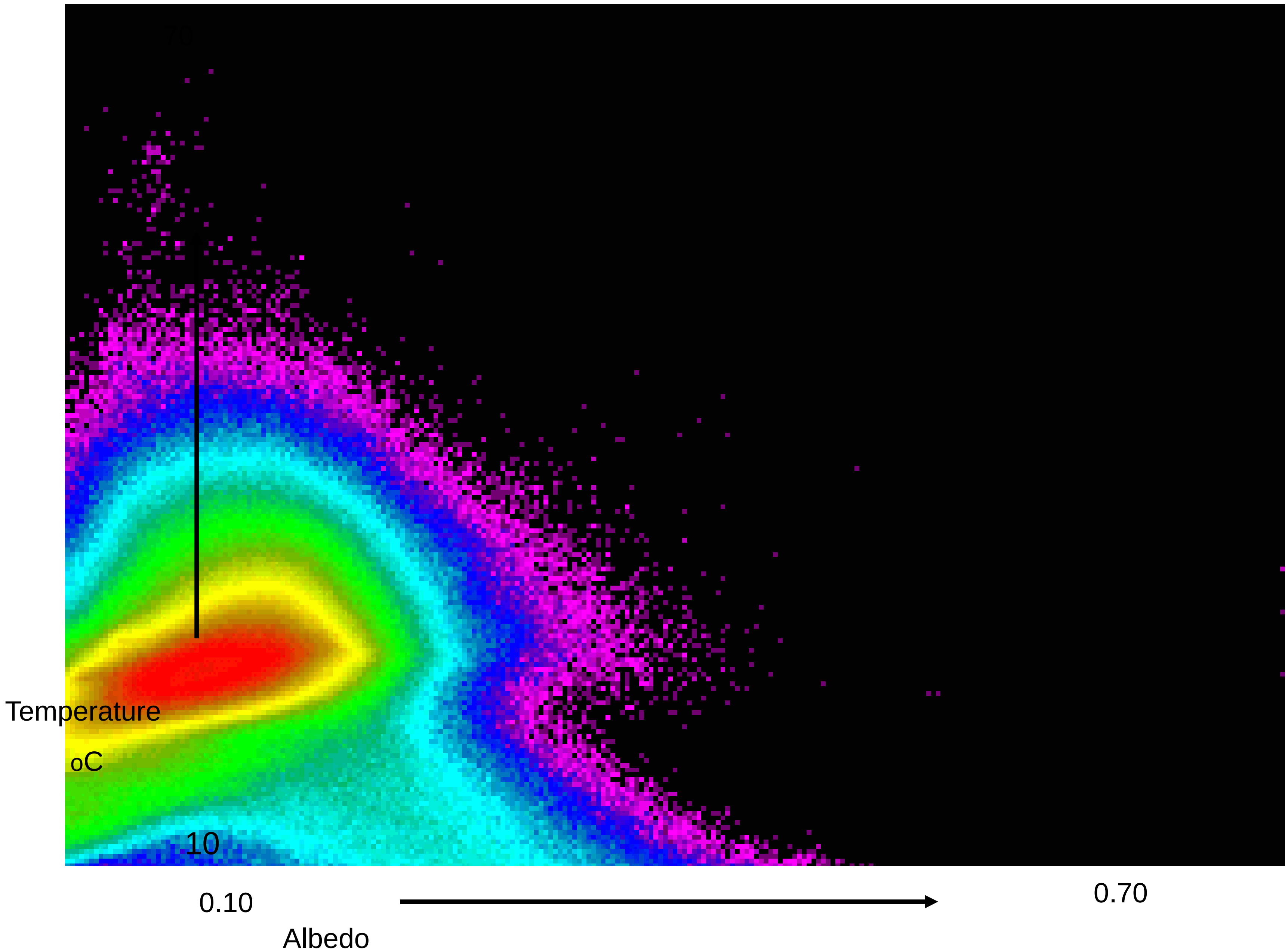




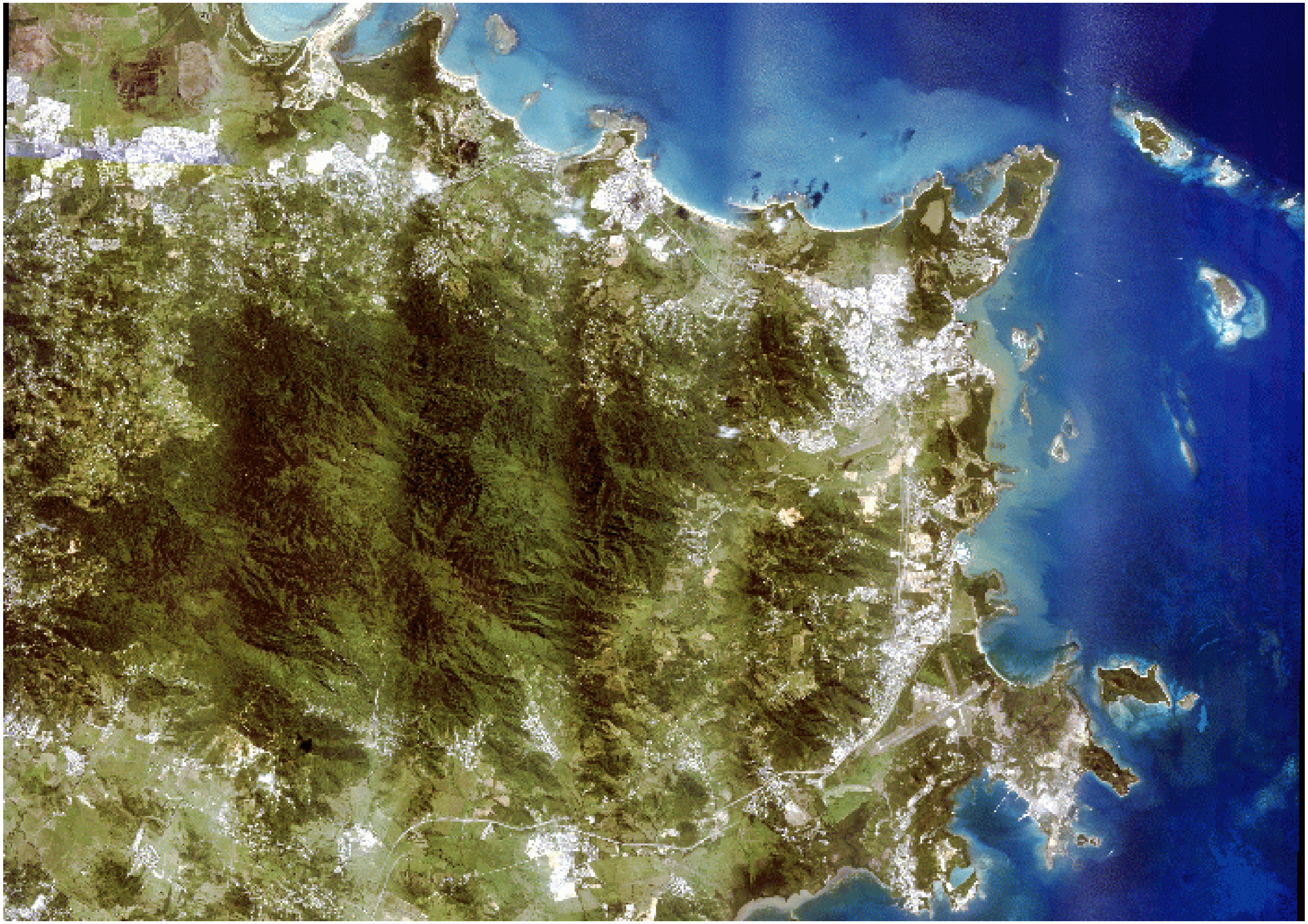

San Juan Urbanizing Area Albedo
Freq %
12
10
8
6
4
2
0
0.10
0.14
0.18
0.22
0.26
0.30
0.35
0.41
0.49
0.60
Albedo


San Juan Urbanizing Area Temperature
Freq %
0
1
2
3
4
5
10
13.3
16.1
18.9
21.8
24.6
27.4
30.2
33.1
35.9
38.9
Temperature oC

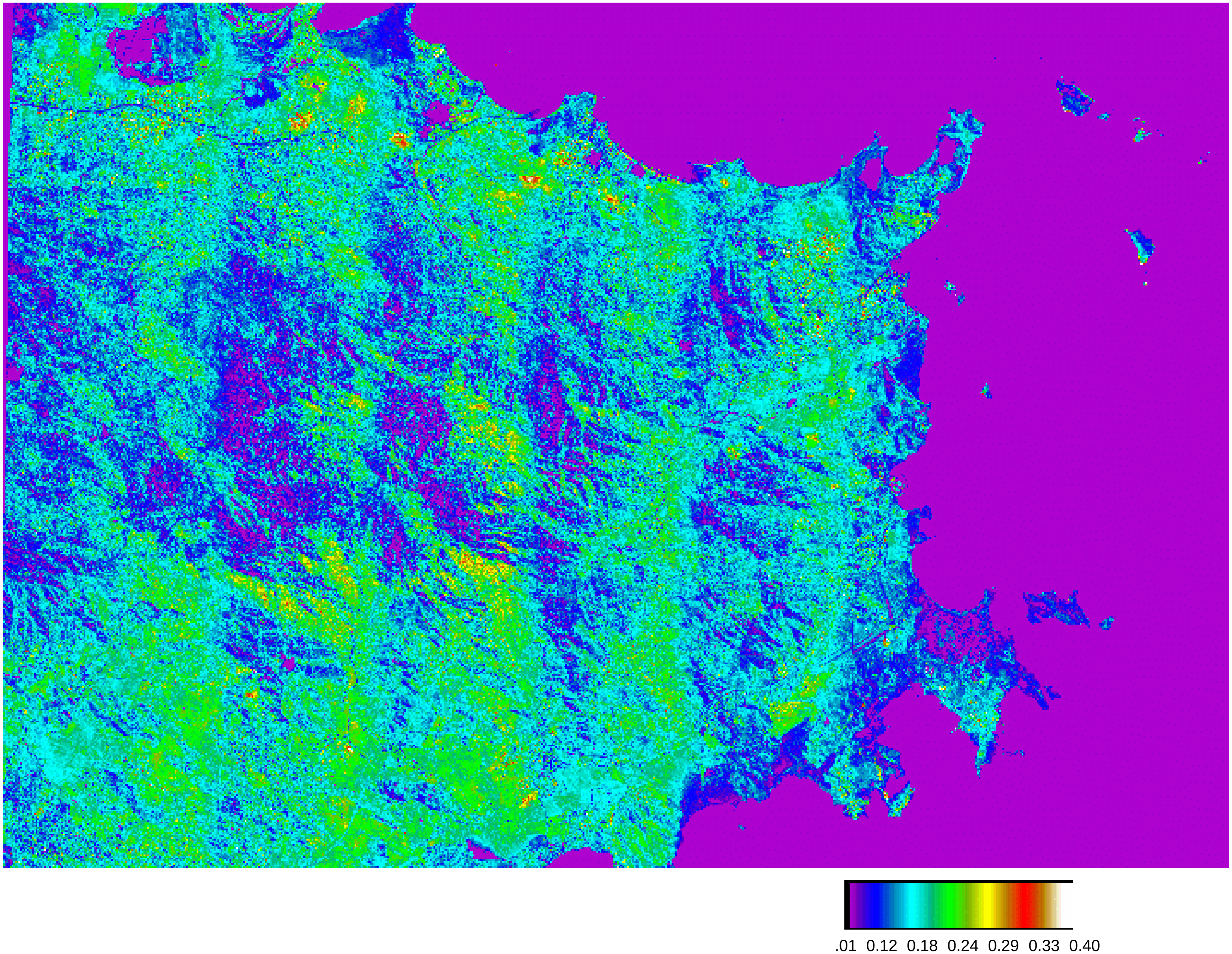
San Juan Puerto Rico Urbanizing Area
Albedo vs Temperature



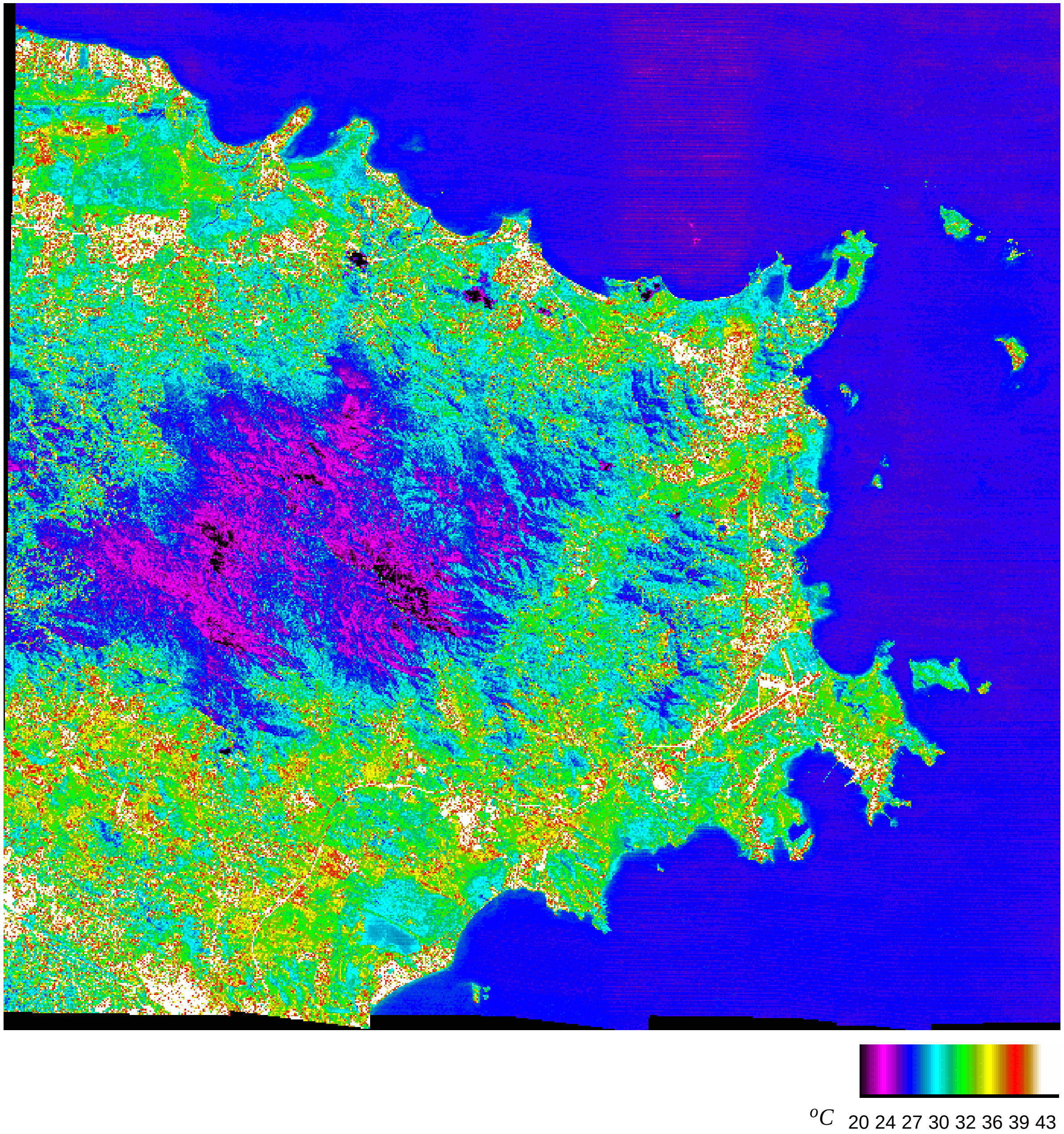
El Yunque F4 Mosaic True Color

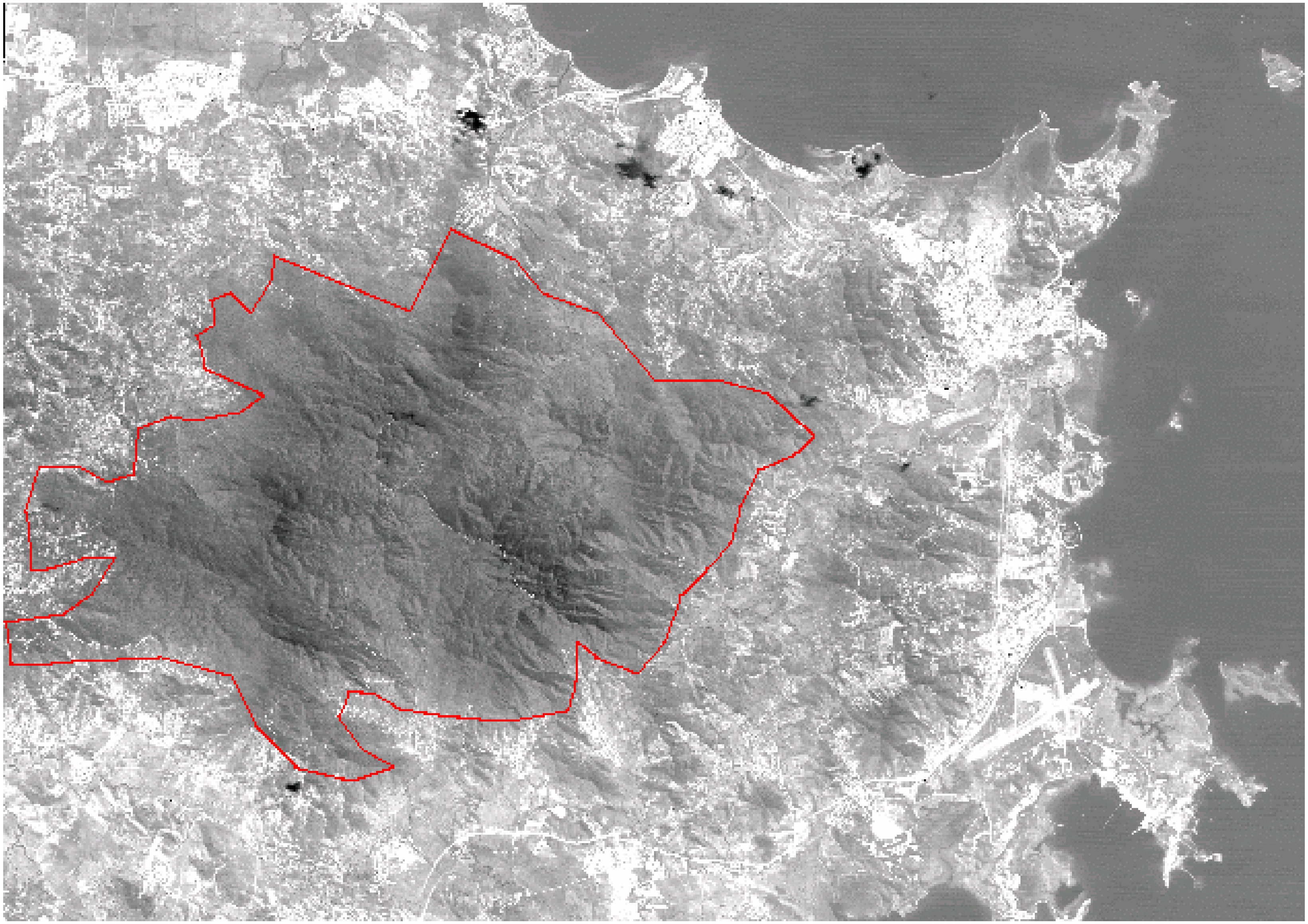


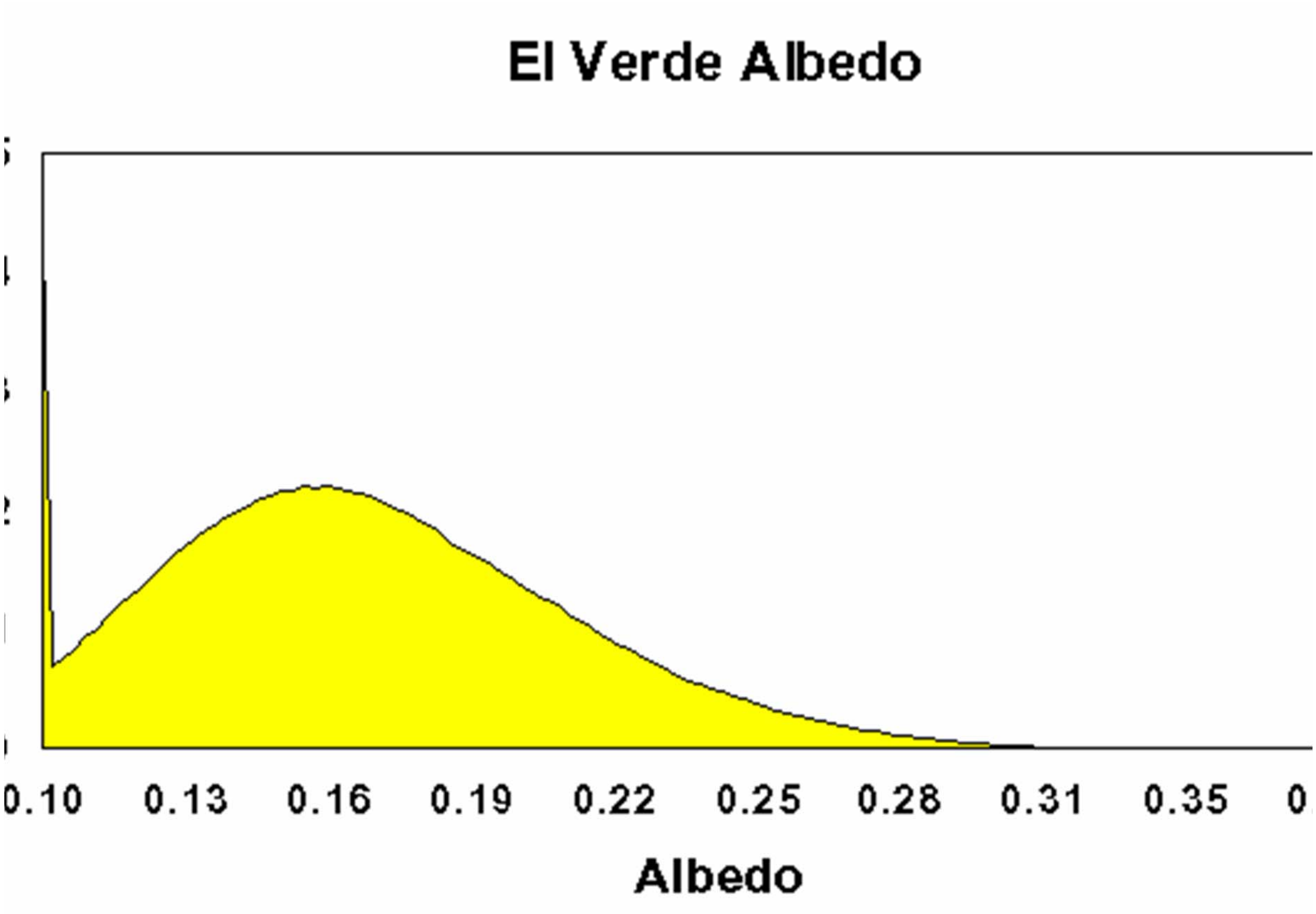
El Yunque F4 Mosaic Albedo



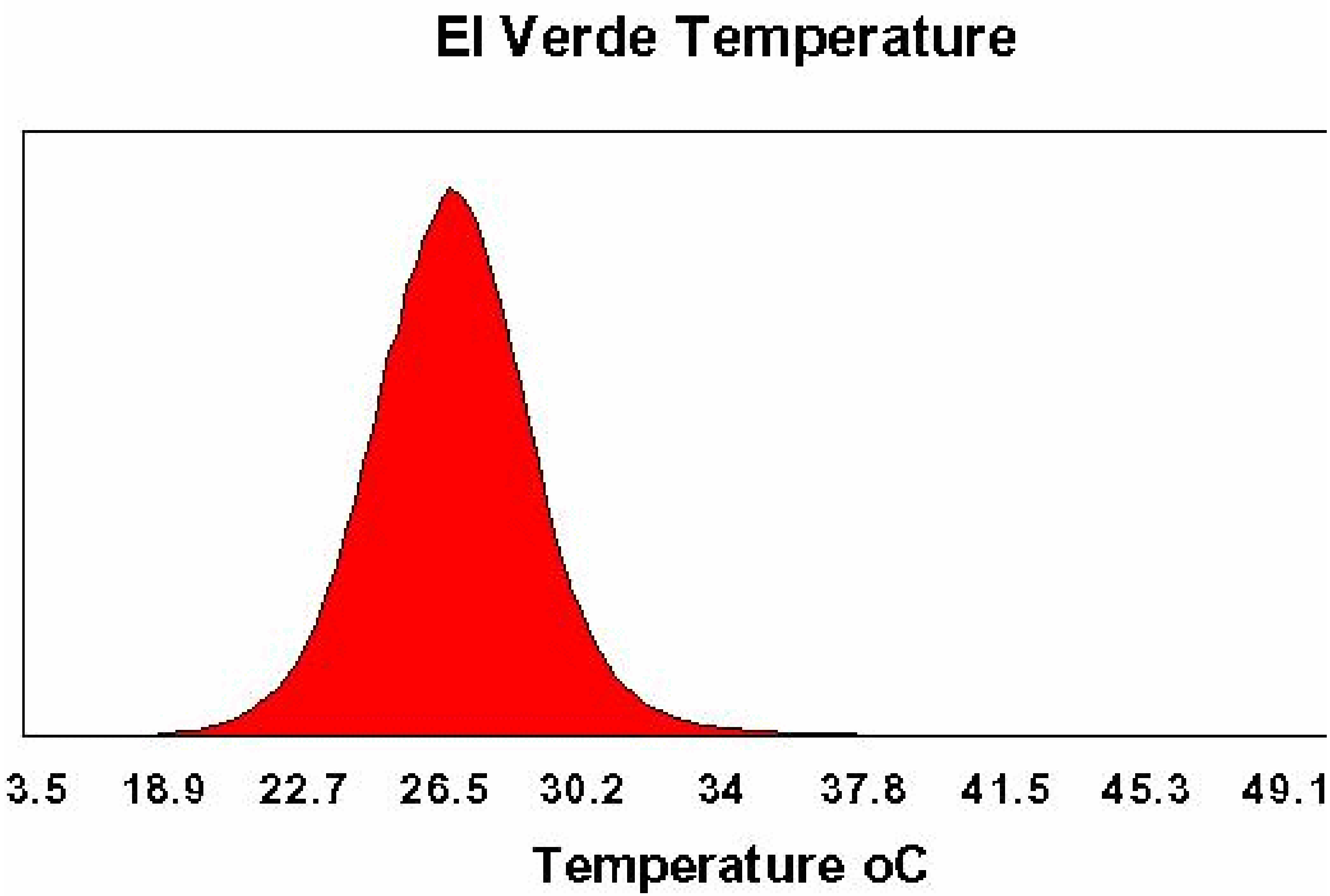
El Yunque F4 Mosaic Temperature



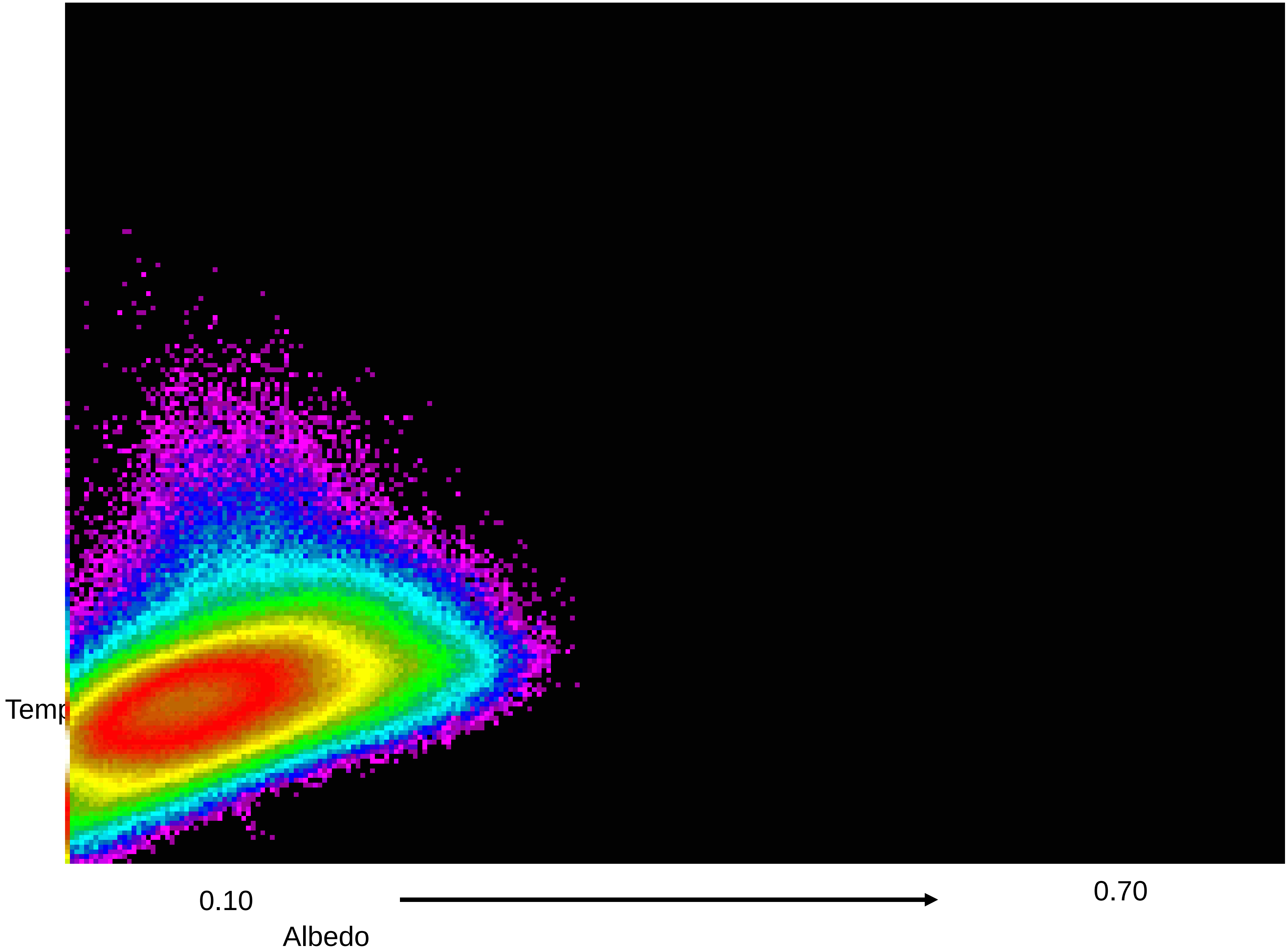


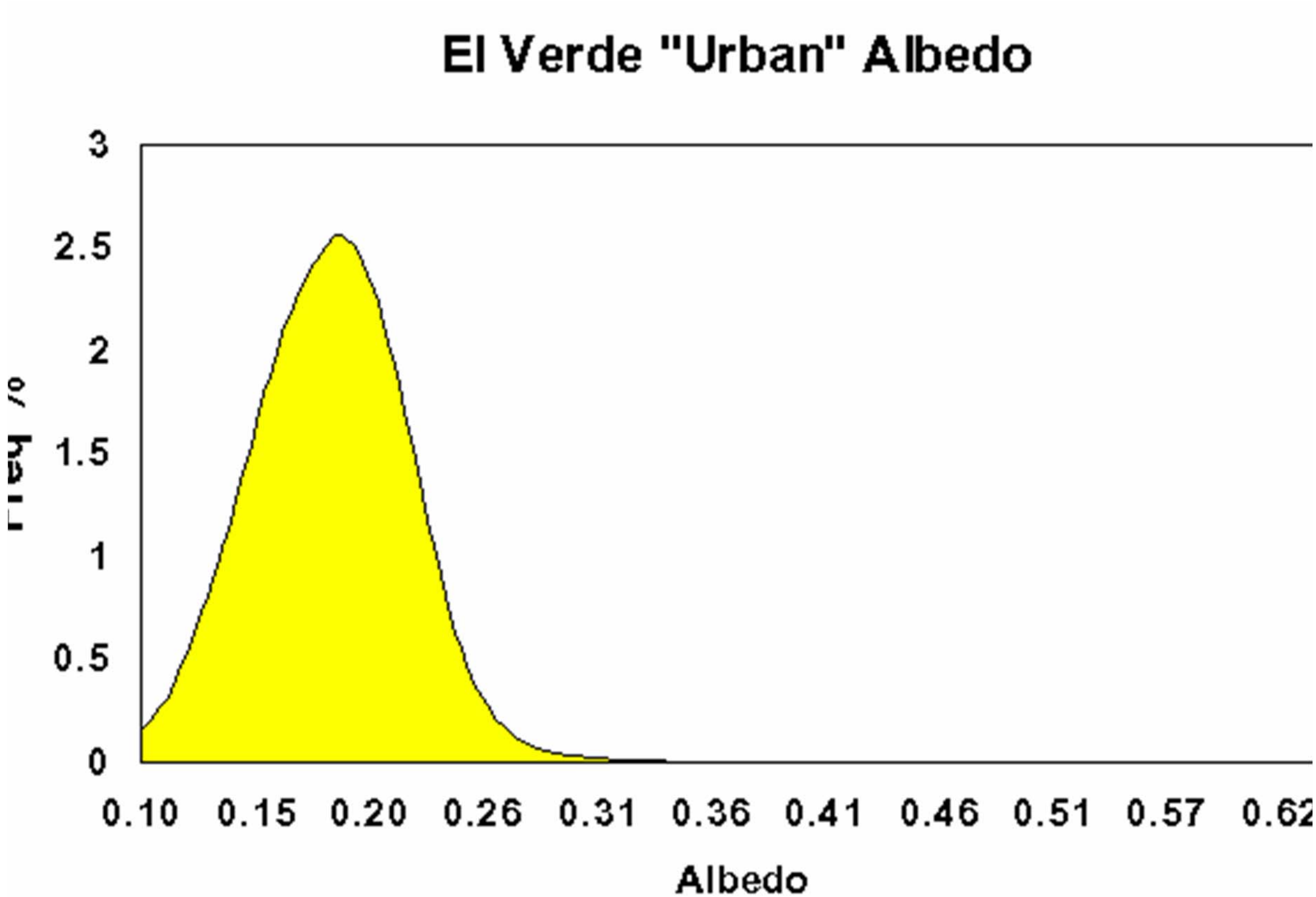


El Verde Albedo
0.10
0.13
0.16
0.19
0.22
0.25
0.28
0.31
0.35
Albedo

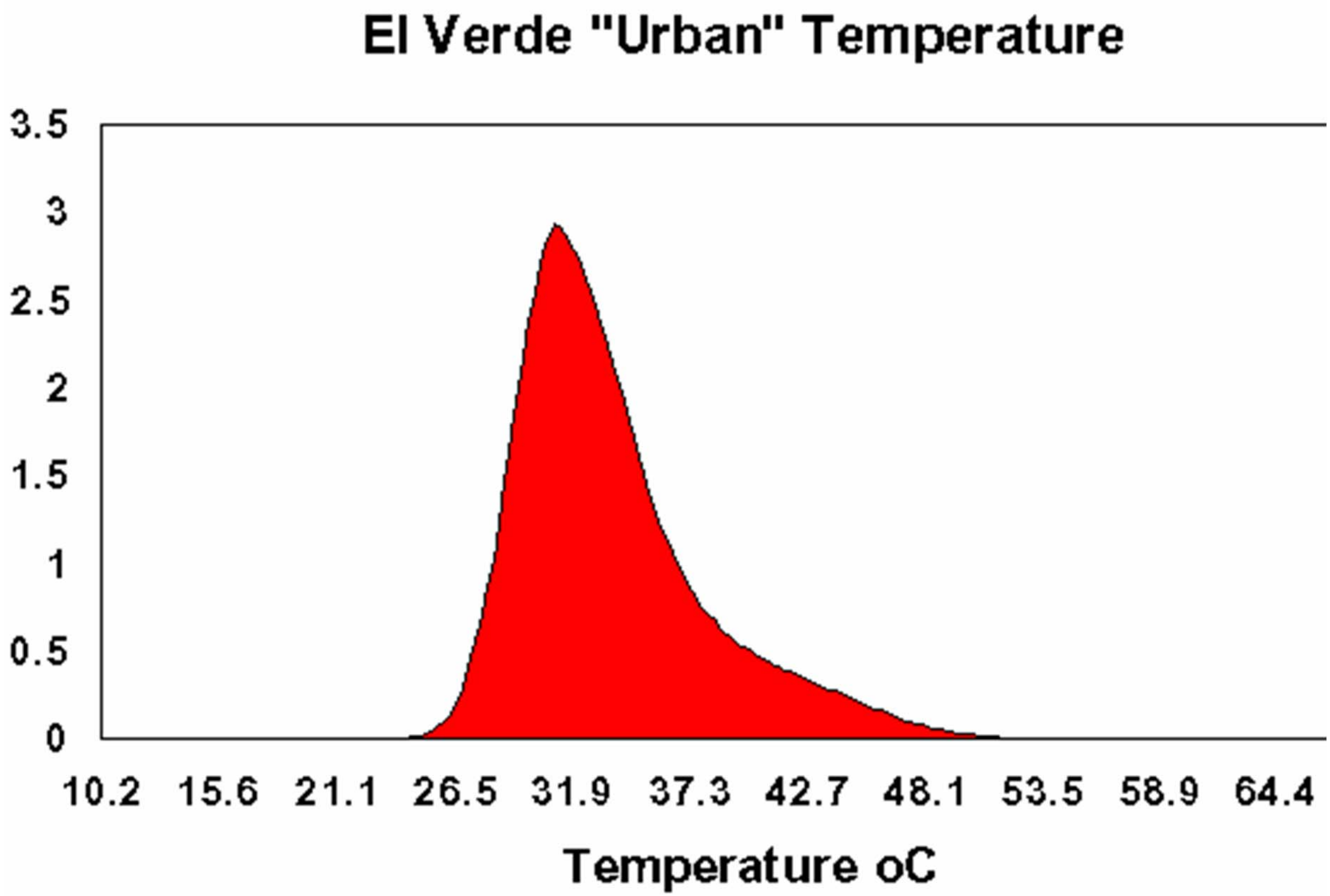

El Verde Temperature
3.5
18.9
22.7
26.5
30.2
34
37.8
41.5
45.3
49.1
Temperature oC

El Yunque
Albedo vs Temperature





El Verde "Urban" Albedo
3
2.5
2
1.5
1
0.5
0
0.10
0.15
0.20
0.26
0.31
0.36
0.41
0.46
0.51
0.57
0.62
Albedo


El Verde "Urban" Temperature
3.5
3
2.5
2
1.5
1
0.5
0
10.2
15.6
21.1
26.5
31.9
37.3
42.7
48.1
53.5
58.9
64.4
Temperature oC

LIFE AS A MANIFESTATION OF THE SECOND LAW OF THERMODYNAMICS

ERIC D. SCHNEIDER
National Ocean Service
National Oceanic and Atmospheric Administration
Washington, D.C., U.S.A.

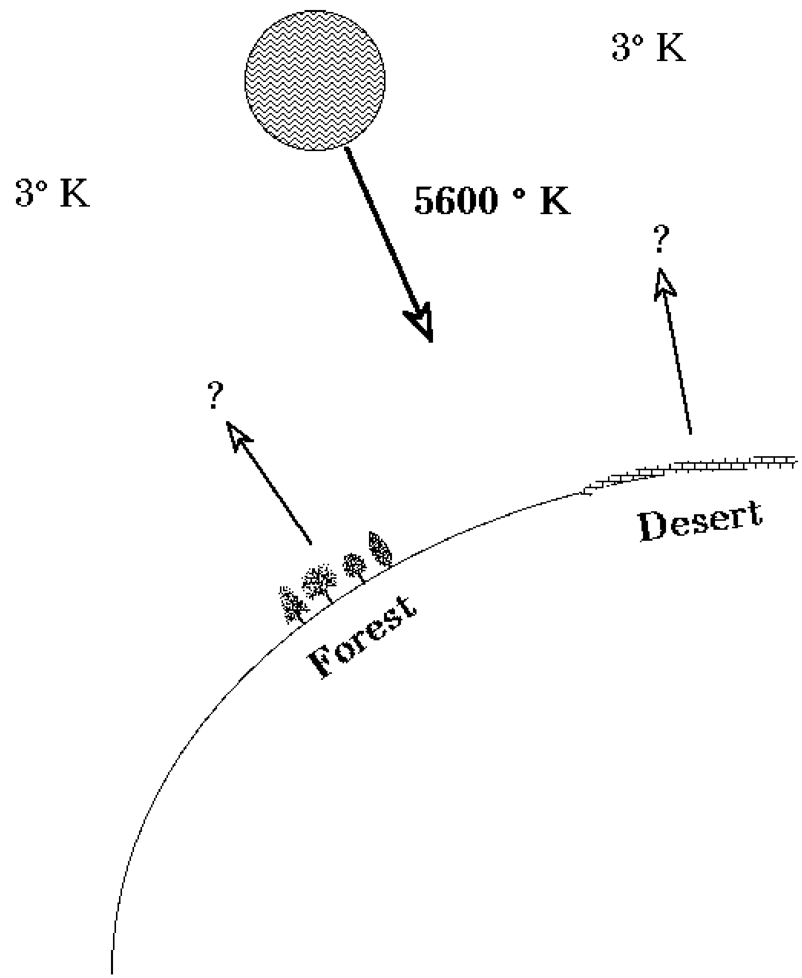
JAMES J. KAY
Environment and Resource Studies
University of Waterloo
Waterloo, Ontario, Canada, N2L 3G1
jjkay@uwaterloo.ca
www.fes.uwaterloo.ca/u/jjkay/

ABSTRACT

We examine the thermodynamic evolution of various evolving systems, from primitive physical systems to complex living systems, and conclude that they involve similar processes which are phenomenological manifestations of the second law of thermodynamics. We take the reformulated second law of thermodynamics of Hatsopoulos and Keenan and Kestin and extend it to nonequilibrium regions, where nonequilibrium is described in terms of gradients maintaining systems at some distance away from equilibrium.

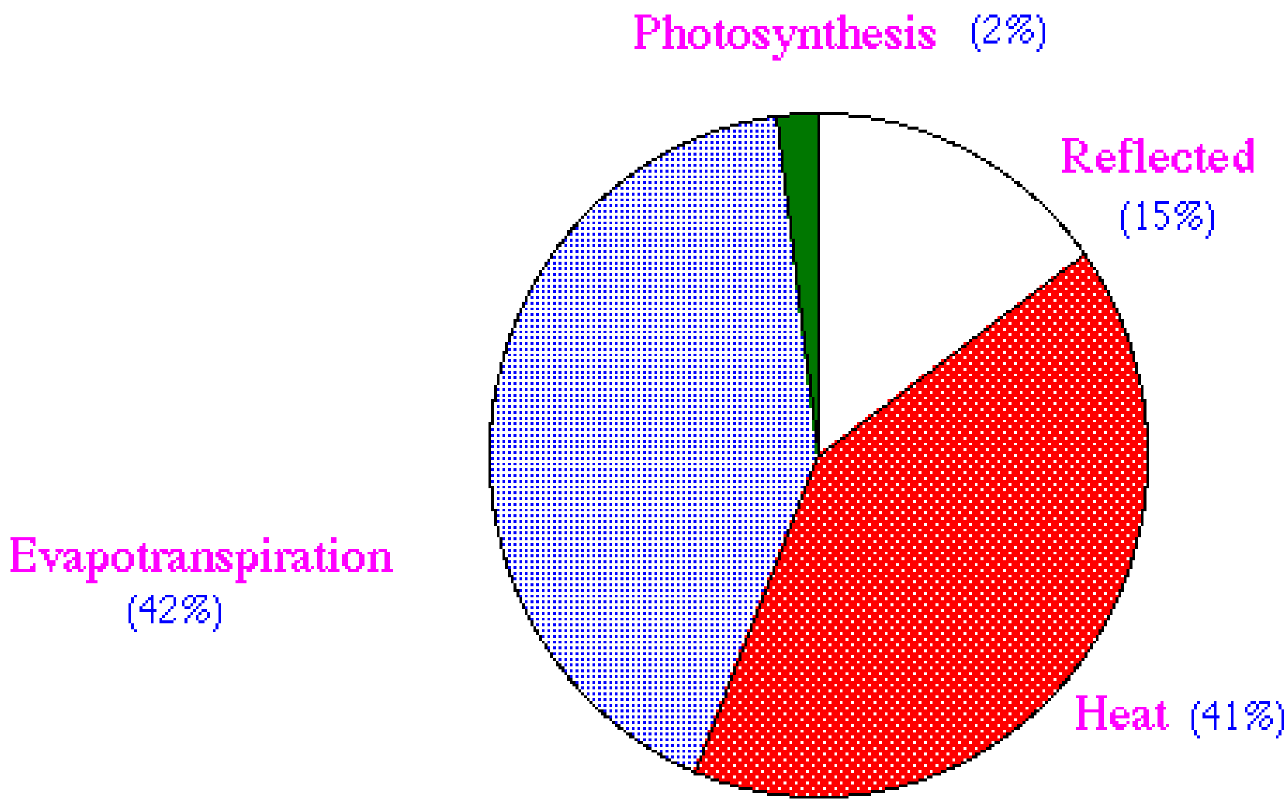
The reformulated second law suggests that as systems are moved away from equilibrium they will take advantage of all available means to resist externally applied gradients. When

Which degrades more energy?



The distribution of solar energy during the growing season in the Hubbard Brook Forested Ecosystem

(From Bormann and Likens, 1978)



Nonequilibrium thermodynamic hypotheses concerning ecosystem development

- Exergy utilization will increase
  - Rn/K* will increase
  - Surface temperature will decrease
- Internal equilibrium will increase
  - Spatial variation in surface temperature will decrease (Beta index increases)
  - Temporal variation in surface temperature will decrease (TRN increases)

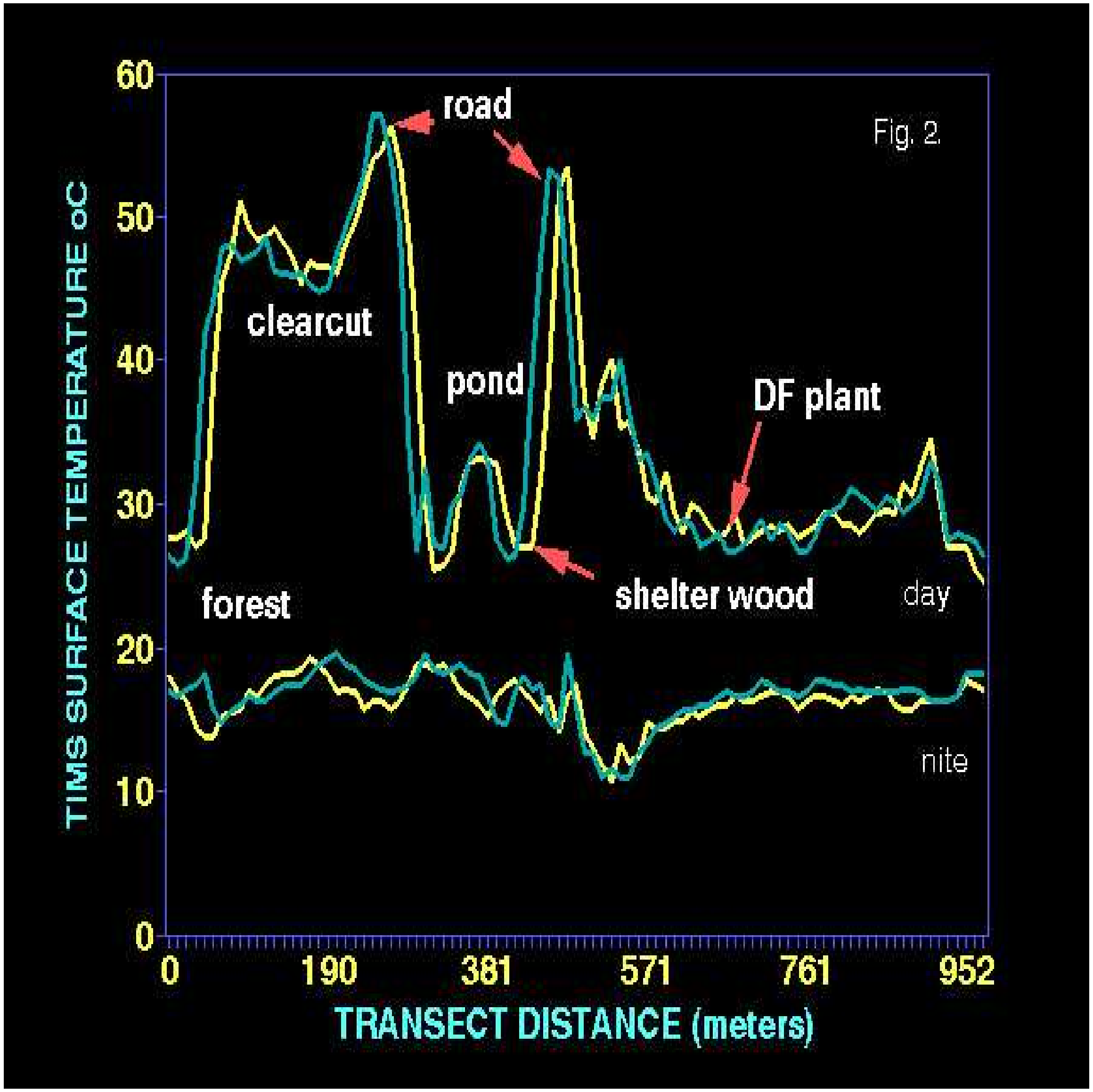
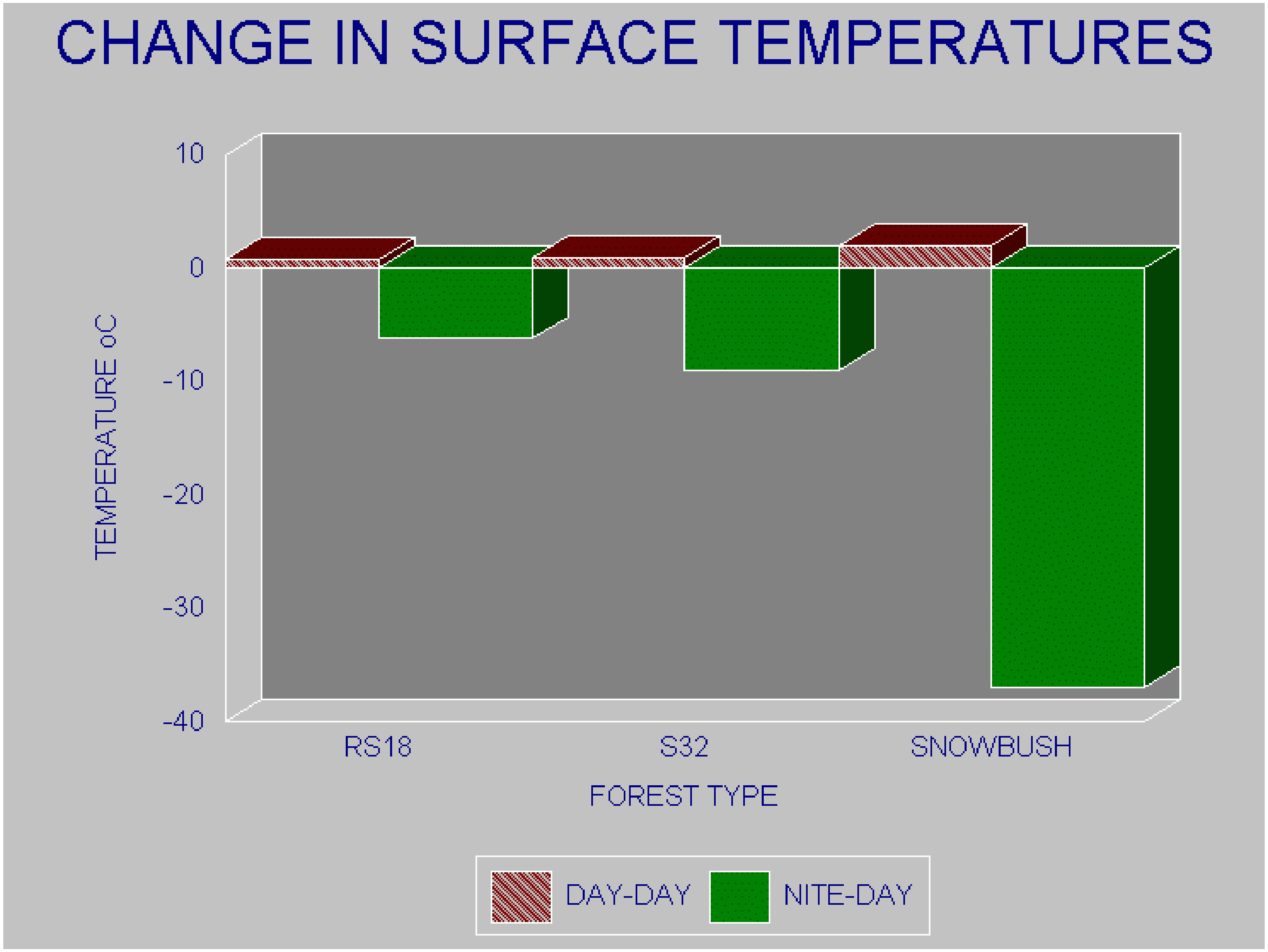


Fig. 2.
TIMS SURFACE TEMPERATURE oC
TRANSECT DISTANCE (meters)
60
50
40
30
20
10
0
0
190
381
571
761
952
road
clearcut
pond
DF plant
shelter wood
forest
day
nite


CHANGE IN SURFACE TEMPERATURES
TEMPERATURE oC
10
0
-10
-20
-30
-40
RS18
S32
SNOWBUSH
FOREST TYPE
DAY-DAY
NITE-DAY

Thermal Response Number

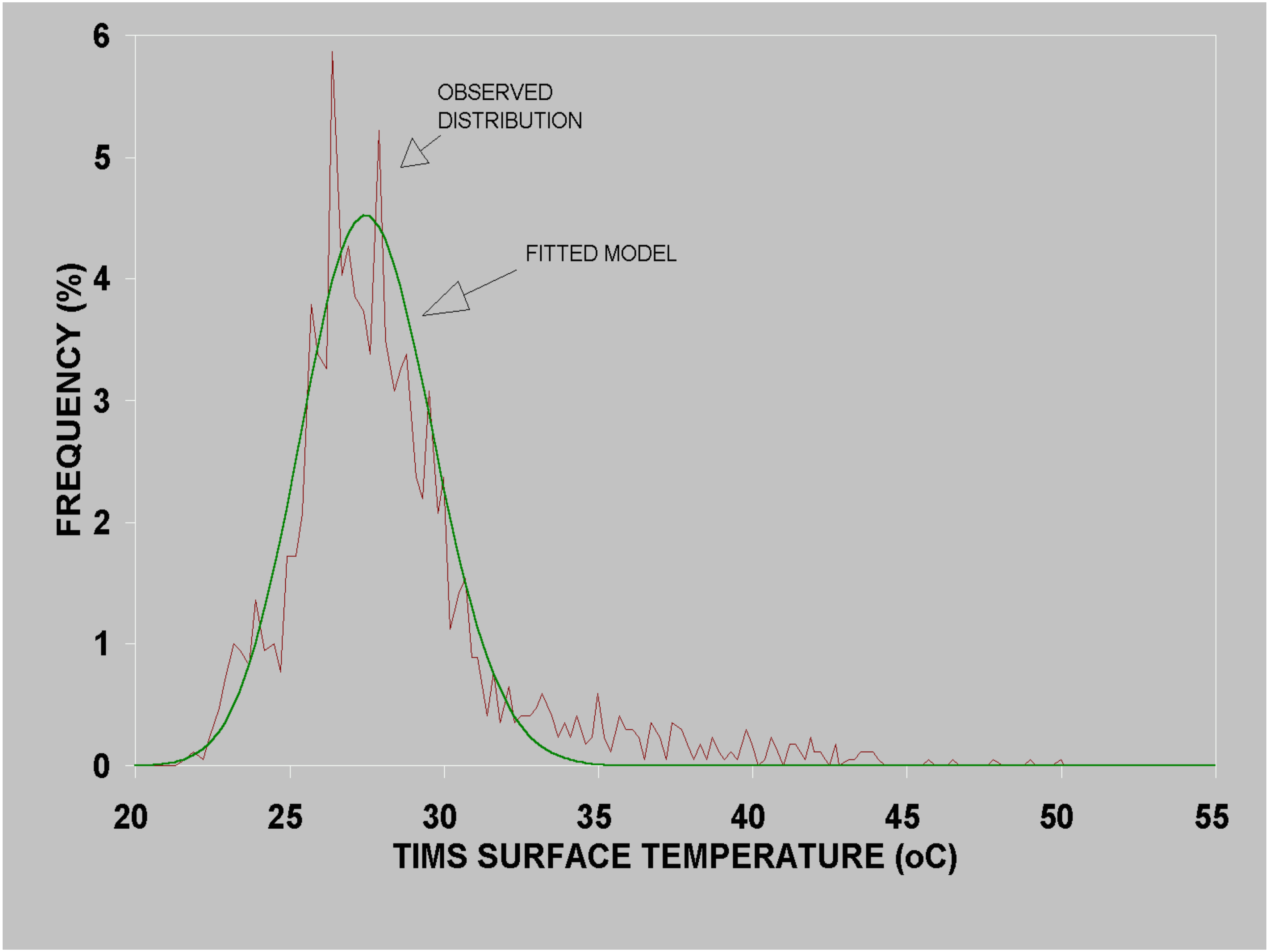
TRN = Q*/delta T

where:

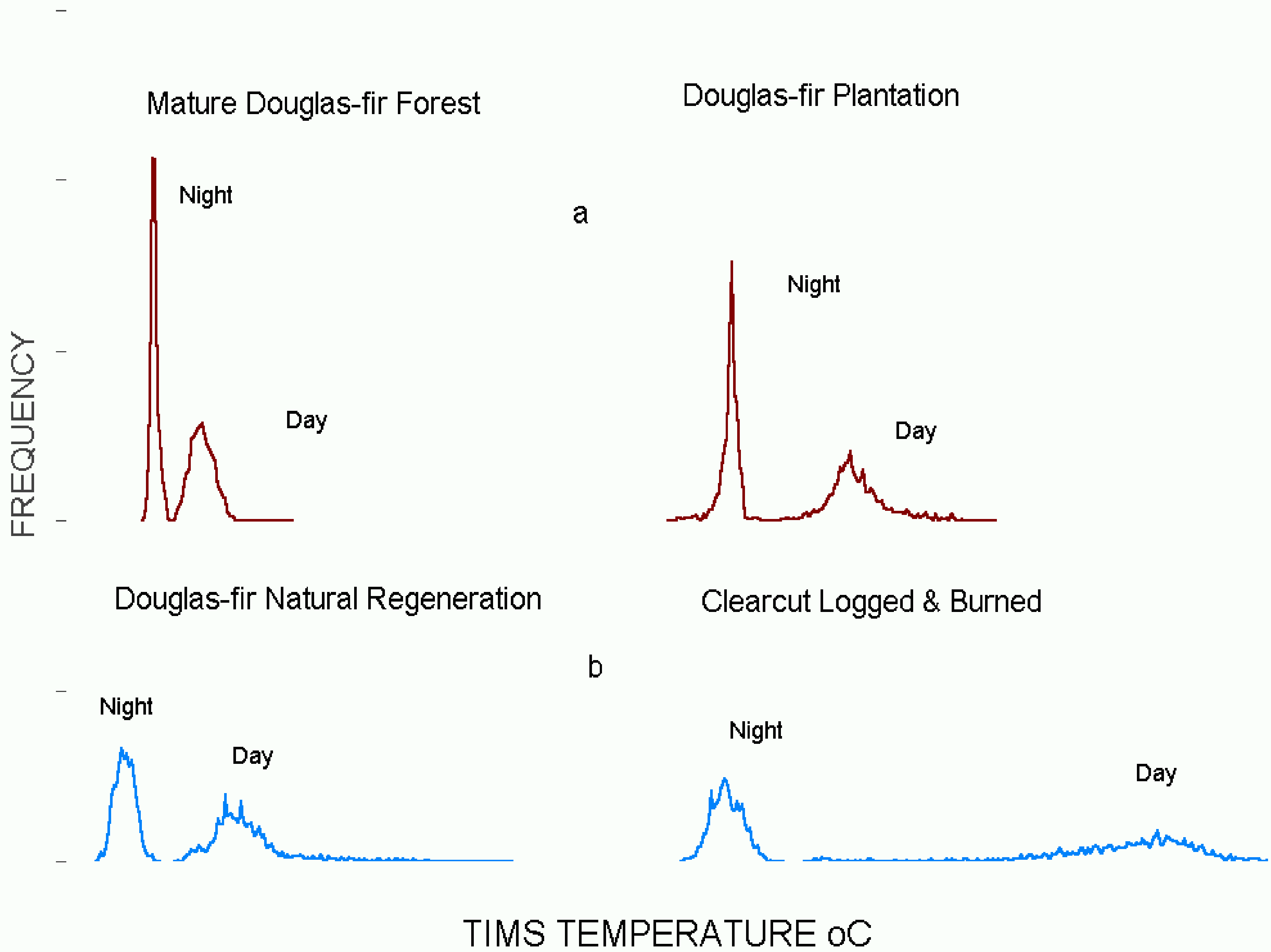
Q* = net radiation

delta T = change in temperature

- Uses the change in surface temperature between 2 measurement times
- Uses surface net radiation as amount of energy available the surface for partitioning
- Produces a quantifiable value (kj m-2 oC -1)
- Allows the classification of land use in terms of energy partitioning



OBSERVED
DISTRIBUTION
FITTED MODEL
FREQUENCY (%)
6
5
4
3
2
1
0
20
25
30
35
40
45
50
55
TIMS SURFACE TEMPERATURE (oC)



Mature Douglas-fir Forest
Douglas-fir Plantation
Night
a
Night
Day
Day
FREQUENCY
Douglas-fir Natural Regeneration
Clearcut Logged & Burned
b
Night
Night
Day
Day
TIMS TEMPERATURE oC

Table 3. Radiative transfer estimates, surface temperatures, Beta Index, and TRN measurements for several surface types at the Andrews Experimental Forest.

	QUARRY	CLRCUT	NATREG	PLANT	MATUREF
K^* W m^{-2}	718	799	895	854	924
Albedo	0.25	0.22	0.15	0.15	0.8
L^* W m^{-2}	273	281	124	124	92
R_n W m^{-2}	445	517	771	730	832
R_n/K^* %	62	65	86	85	90
T °C	50.7	51.8	29.4	29.5	24.3
ΔT °C	4.5	2.2	1.7	0.8	0.7
Beta Parameter α, β	41,8	20,4	55,95	120,200	210,520
Beta Index[1]	-12.9	-6.3	17.2	34.4	130.1
TRN k J m^{-2} °C^{-1}	168	406	788	1,631	2063

K^* = net incoming solar radiation, L^* = net long wave , R_n = net radiation, R_n/K^* = percent of net incoming solar radiation degraded into non-radiative processes. T = averaged site surface temperatures from first and second flights.

[1] Beta index values were calculated from the second mid-day flight.

Conclusions

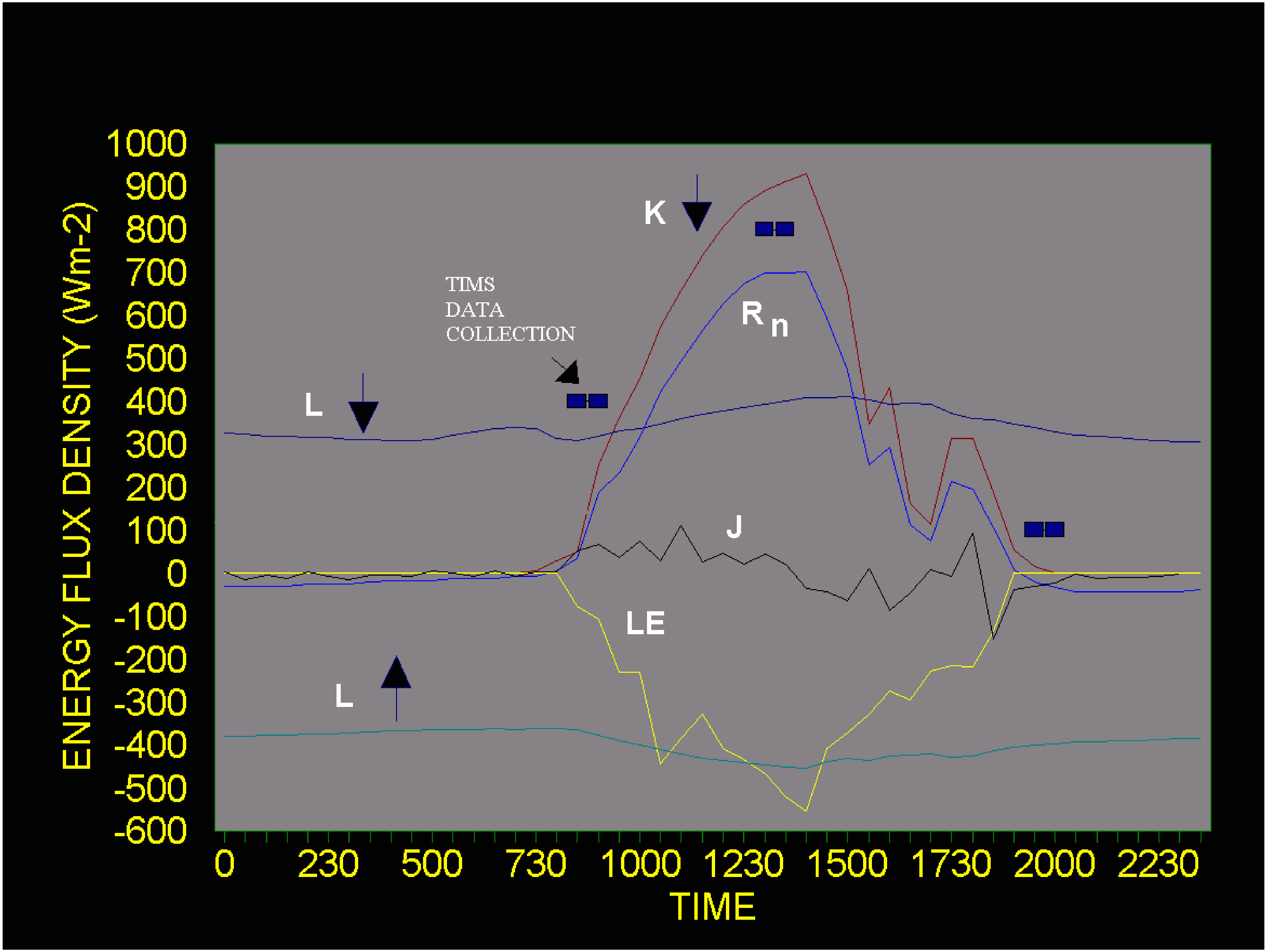
- Ecosystems develop structure and function that degrades the quality of the incoming energy more effectively.
- The ecosystem T and Rn/K * and TRN are excellent candidates for indicators of ecological integrity.
- The potential for these methods to be used for remote sensed ecosystem classification and ecosystem health/integrity evaluation is apparent.

Surface Temperature

$$T_s = T_a + \frac{R_b}{C_\rho}\left(R_n - E\right)$$

Penman Monteith equation

$$E = \left(\frac{s\left(R_n - G\right) + \left[\dfrac{\rho_a C_\rho D}{R_a} \right]}{s + \gamma \left[1 + \dfrac{R_c}{R_a} \right]} \right)$$


ENERGY FLUX DENSITY (Wm-2)
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
-300
-400
-500
-600
K
TIMS
DATA
COLLECTION
R n
L
J
LE
L
0
230
500
730
1000
1230
1500
1730
2000
2230
TIME

Direct Measurement of Evapotranspiration and Carbon Sequestration Via Remote Sensing

Precision Agriculture:

A cooperative project
between Alabama, Georgi
NASA

Funded by AL and GA Space
Grant Consortia

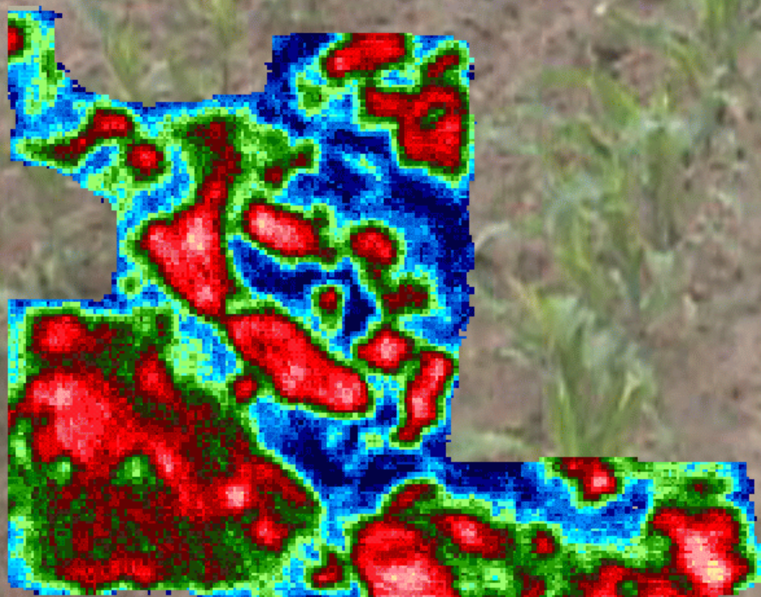
Find and map the differences between and within fields.
Make the farmer more profit!

Fields are treated as uniform blocks.

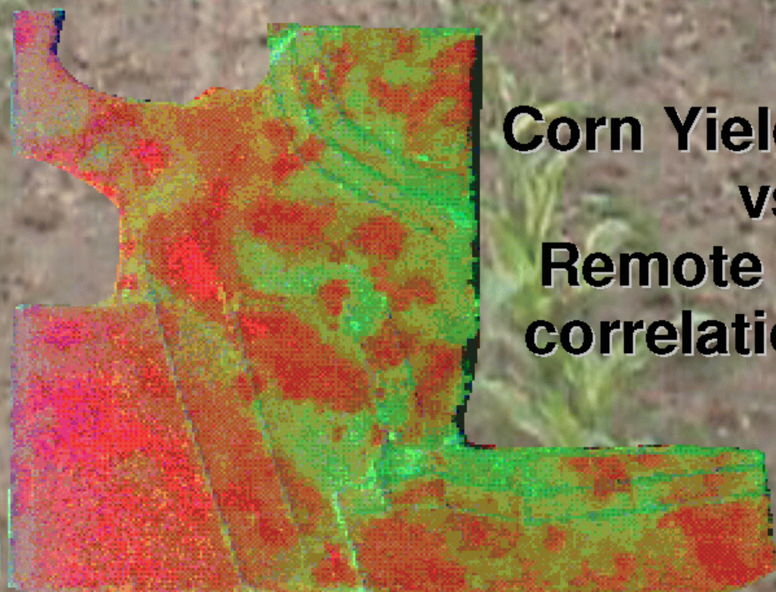
But fields are very heterogeneous on the scale of a few meters!

Remote Sensing can

- map soils
- find variation in crop vigo
- predict yield 2 months before harvest



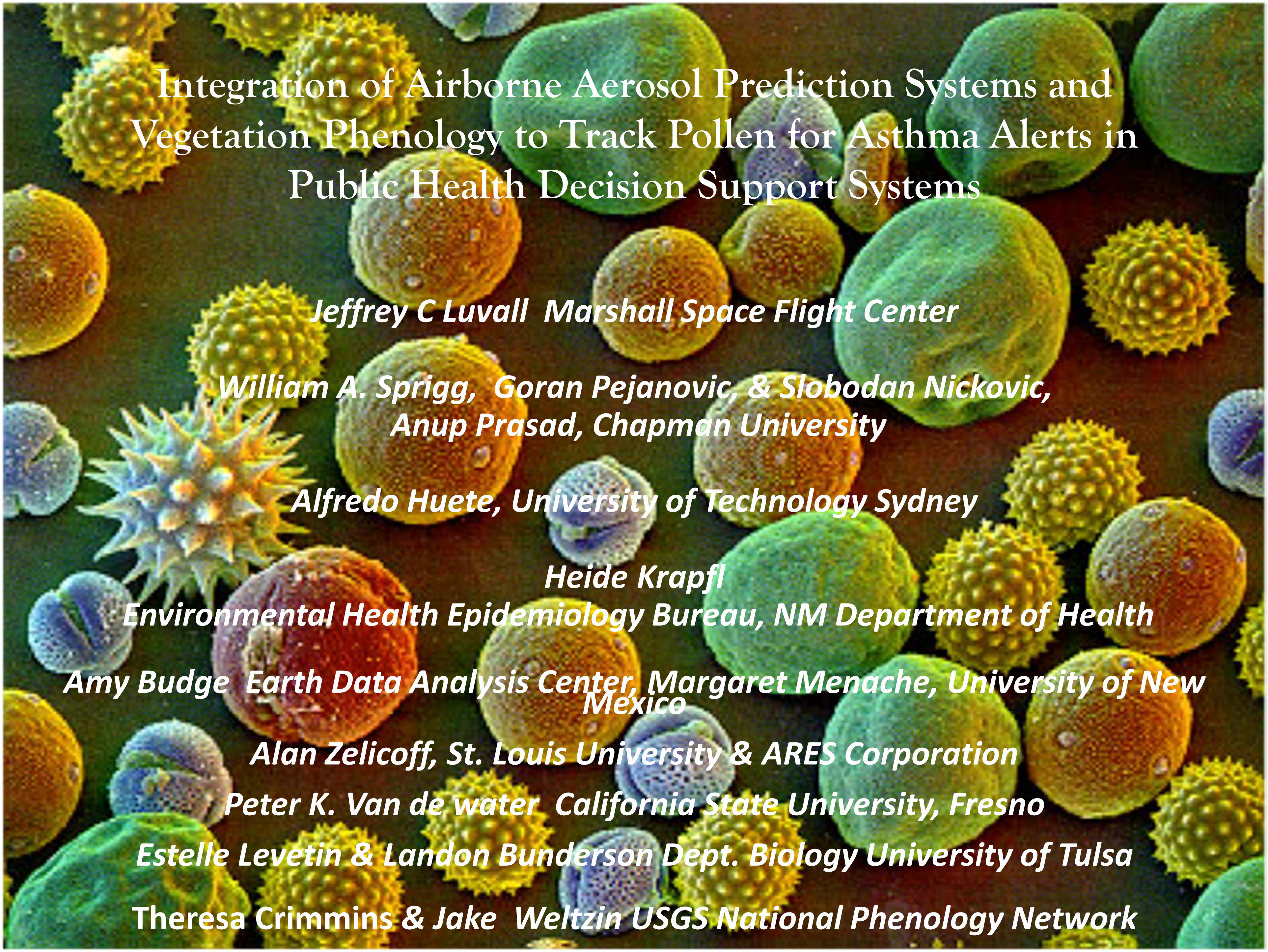
Harvest- September, 1998



Overflight- June 26, 1998

Corn Yield (far left)
vs.
Remote Sensing
correlation > 0.87

D. Rickman, et al., 199



Integration of Airborne Aerosol Prediction Systems and Vegetation Phenology to Track Pollen for Asthma Alerts in Public Health Decision Support Systems

Jeffrey C Luvall Marshall Space Flight Center

William A. Sprigg, Goran Pejanovic, & Slobodan Nickovic,
Anup Prasad, Chapman University

Alfredo Huete, University of Technology Sydney

Heide Krapfl
Environmental Health Epidemiology Bureau, NM Department of Health

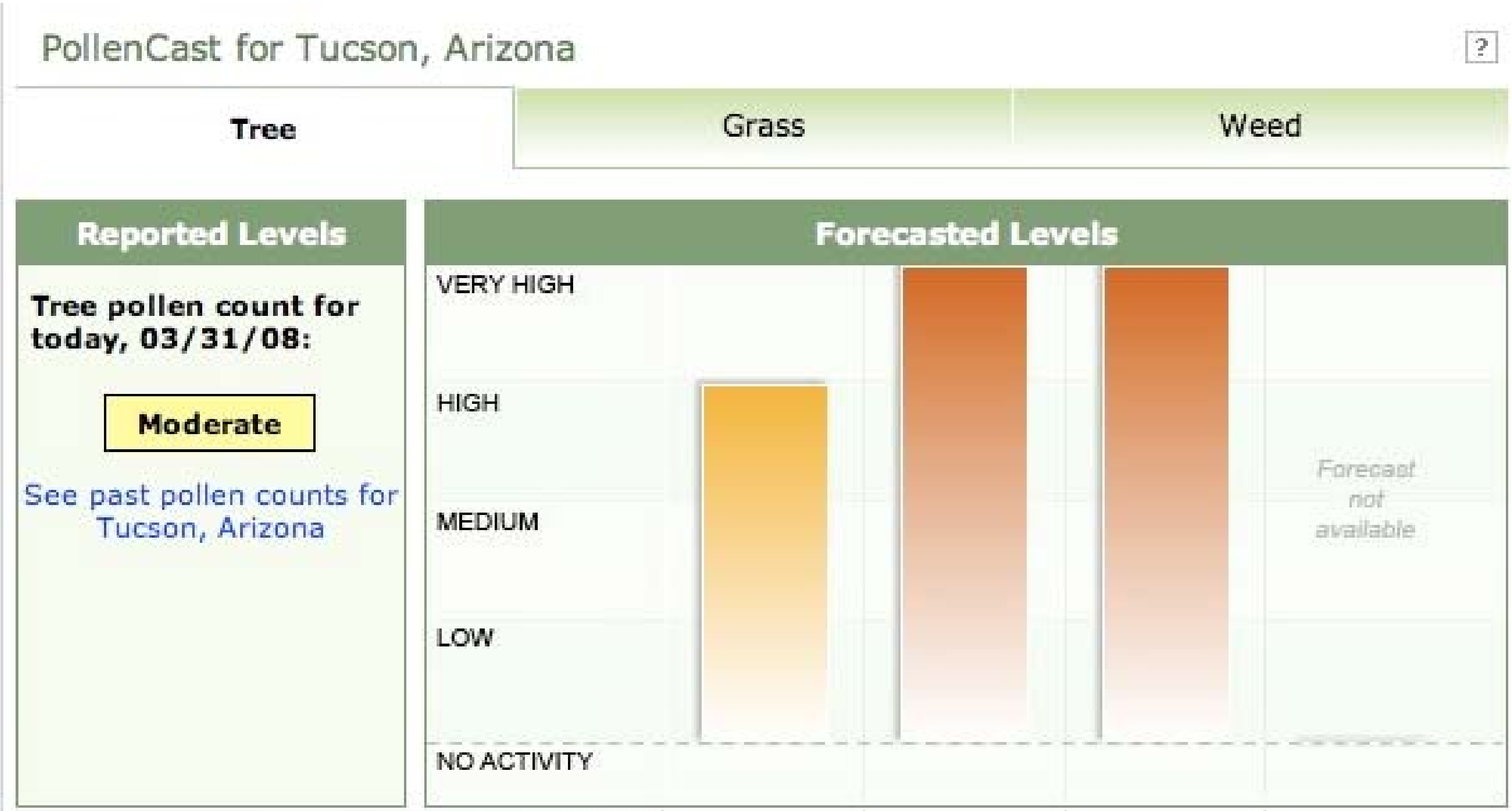
Amy Budge Earth Data Analysis Center, Margaret Menache, University of New Mexico

Alan Zelicoff, St. Louis University & ARES Corporation

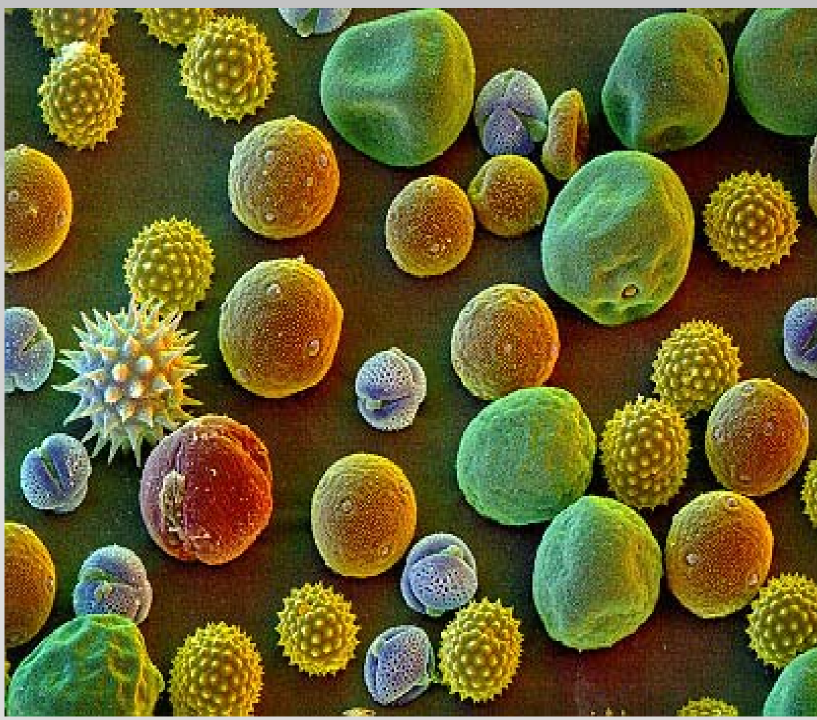
Peter K. Van de water California State University, Fresno

Estelle Levetin & Landon Bunderson Dept. Biology University of Tulsa

Theresa Crimmins & Jake *Weltzin USGS National Phenology Network*


PollenCast for Tucson, Arizona
?
Tree
Grass
Weed
Reported Levels
Tree pollen count for today, 03/31/08:
Moderate
See past pollen counts for Tucson, Arizona
Forecasted Levels
VERY HIGH
HIGH
MEDIUM
LOW
NO ACTIVITY
Forecast not available

Top pollen-producing species



Los Alamos	Albuquerque
juniper	mulberry
sagebrush	juniper
pine	ash
Alternaria*	goosefoot
oak	cottonwood
grass	grass
ragweed	sagebrush
goosefoot	pine
Cladosporium*	elm
Myxomycete*	aster
cottonwood	ragweed
mulberry	sycamore
aster	oak
elm	willow

*fungal / slime mold spores

Pollen and Respiratory Disease: What little is known[2]

Increase in mortality of these disorders:

	Poaceae pollen concentrations (grains per m³ air)			
	<22	22–77	78–135	>135
	Relative risk	Relative risk (95% CI)	Relative risk (95% CI)	Relative risk (95% CI)
Cardiovascular disease	1·000	1·015 (1·002–1·029)	1·012 (0·994–1·029)	1·061 (1·038–1·084)
Chronic obstructive pulmonary disease	1·000	1·095 (1·053–1·139)	1·124 (1·069–1·181)	1·150 (1·079–1·225)
Pneumonia	1·000	1·104 (1·049–1·163)	1·093 (1·023–1·168)	1·168 (1·077–1·266)
Total	1·000	1·019 (1·010–1·028)	1·019 (1·008–1·031)	1·043 (1·028–1·058)

- High concentrations of pollen allergens have also been shown to occur in thoracic particles (<10 microns in diameter) and respirable particles (<2·5 microns and these correlated well in time with airborne pollen concentrations. … airborne pollen results in exposure of the lower airways and lung to pollen allergens.

- The association between air pollution and the number of daily deaths may be related to the inflammatory potential of very small particles

- …suggests that high airborne pollen concentrations, which nowadays are mainly seen as triggers of allergic symptoms, may have far more serious effects than previously thought.”

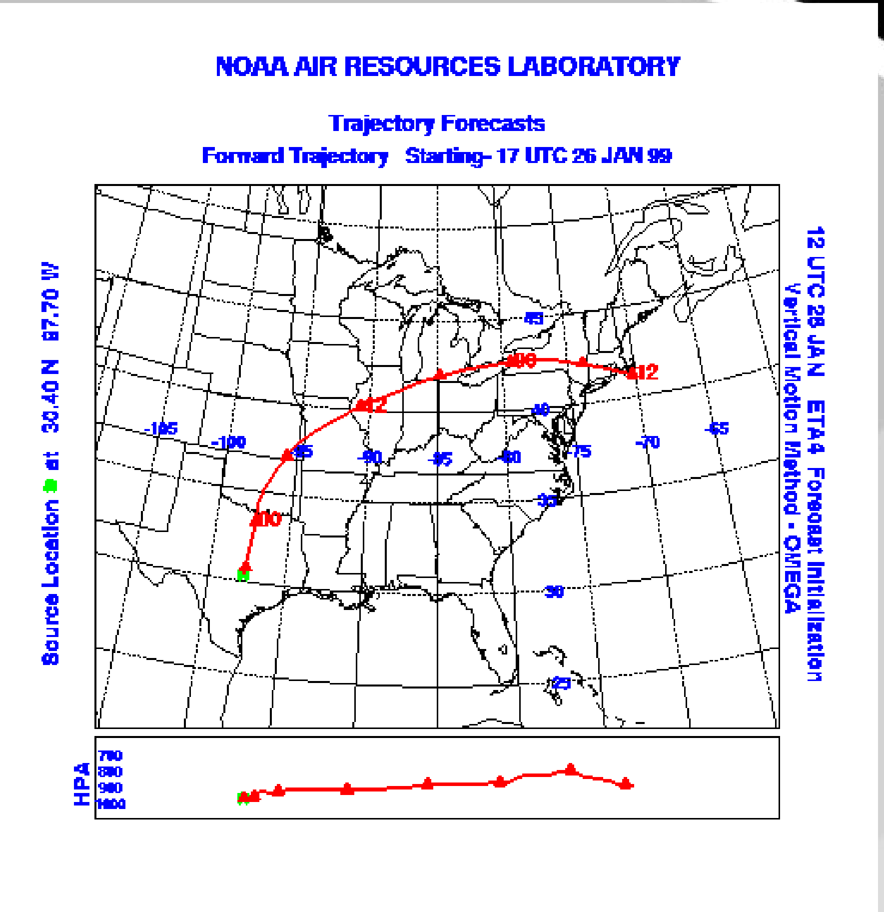
[2] Bert Brunekreef, Gerard Hoek, Paul Fischer, Frits Th M Spieksma. Relation between airborne pollen concentrations and daily cardiovascular and respiratory-disease mortality. Lancet Vol 355 (2000): 1517-8.

Limitations of Pollen Sampling

- Lack of stations
- Count frequency & reporting lag time
- Different sampling instruments Rotorod Sampler/Burkard Spore Trap
- Only indentifiable pollen “grains”
- Expertise in counting/indentification
- Refusal to release sampling information-”*We do not reveal the sources for our data for privacy and proprietary, competitive reasons. Some pollen counts are conducted privately, and are not meant to be broadcast to the public* ”

Continental transport

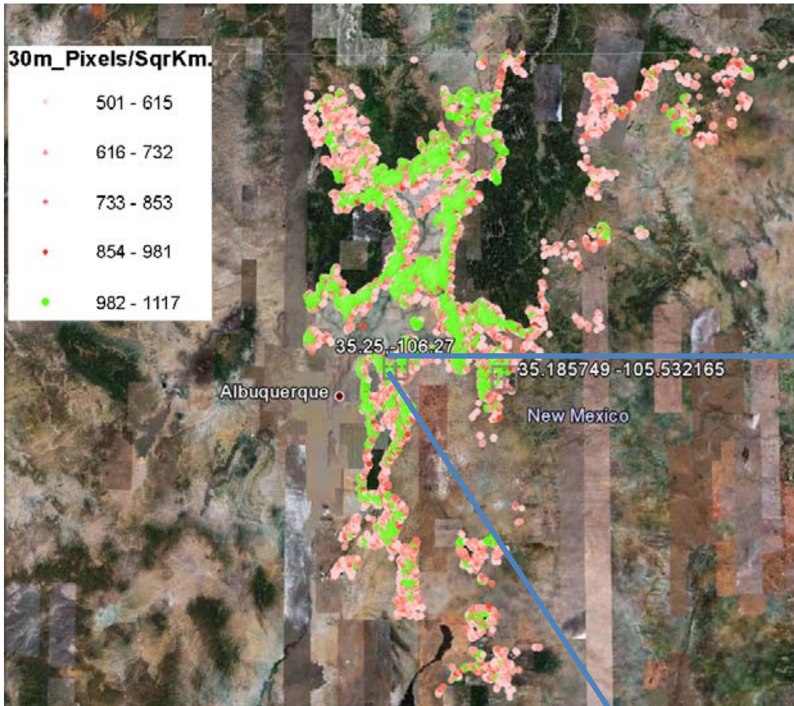
- 27 Jan 99, Jim Anderson in London, Ontario reported atmospheric *Juniperus* pollen - 58 pollen grains/m^3
- Trajectories show that the source of this pollen was Texas population of *Juniperus ashei*
- Our Jan 26 forecast indicated that the "pollen has the potential to travel very long distances."



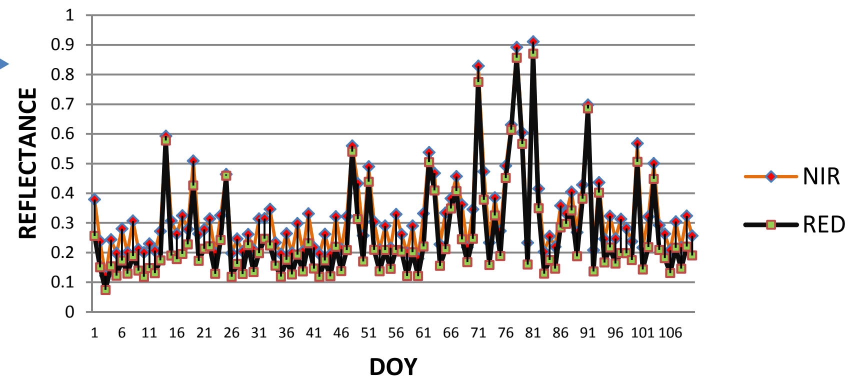
Van de Water et. al 2003

Site 1 S038

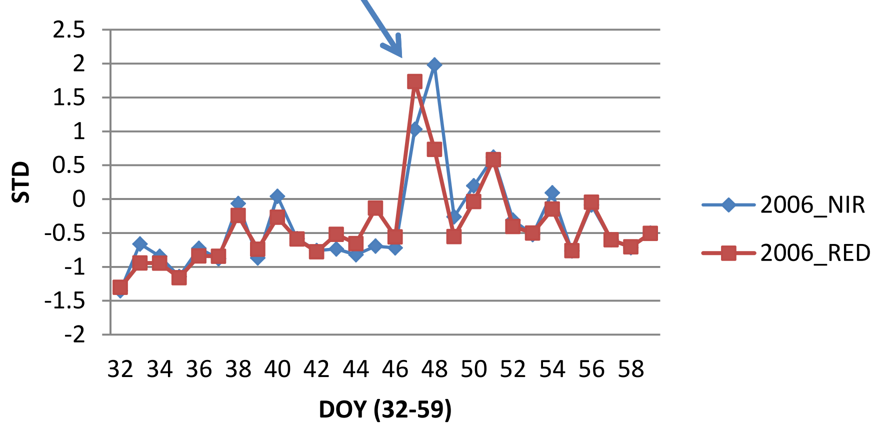
Density of S038 class



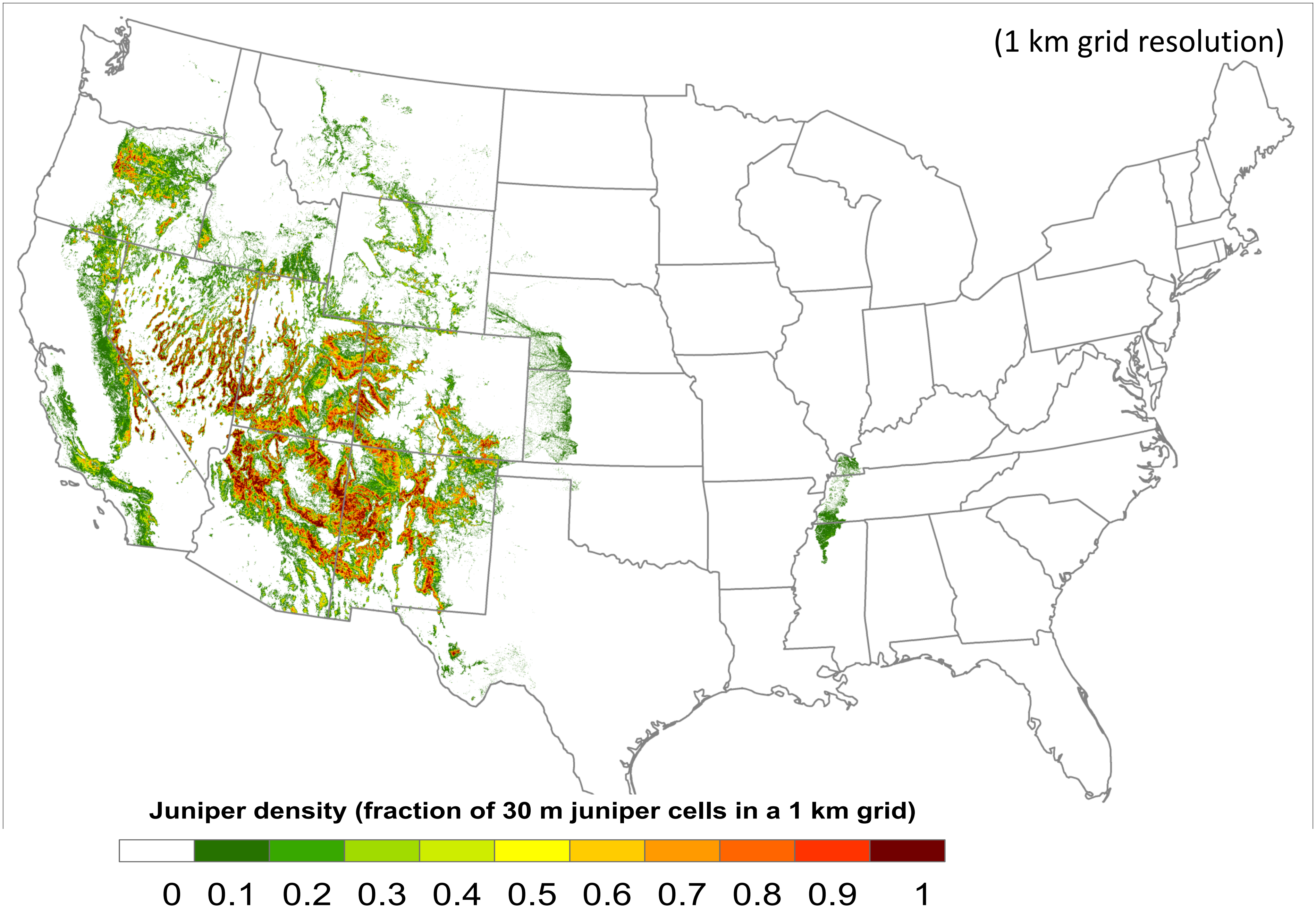
2006 Daily_250m pixel (MOD09GQ) Site_1 (20 Miles east-Albuquerque)



Anomaly_MOD09GQ_250m-Pixel Site1 - February-2006



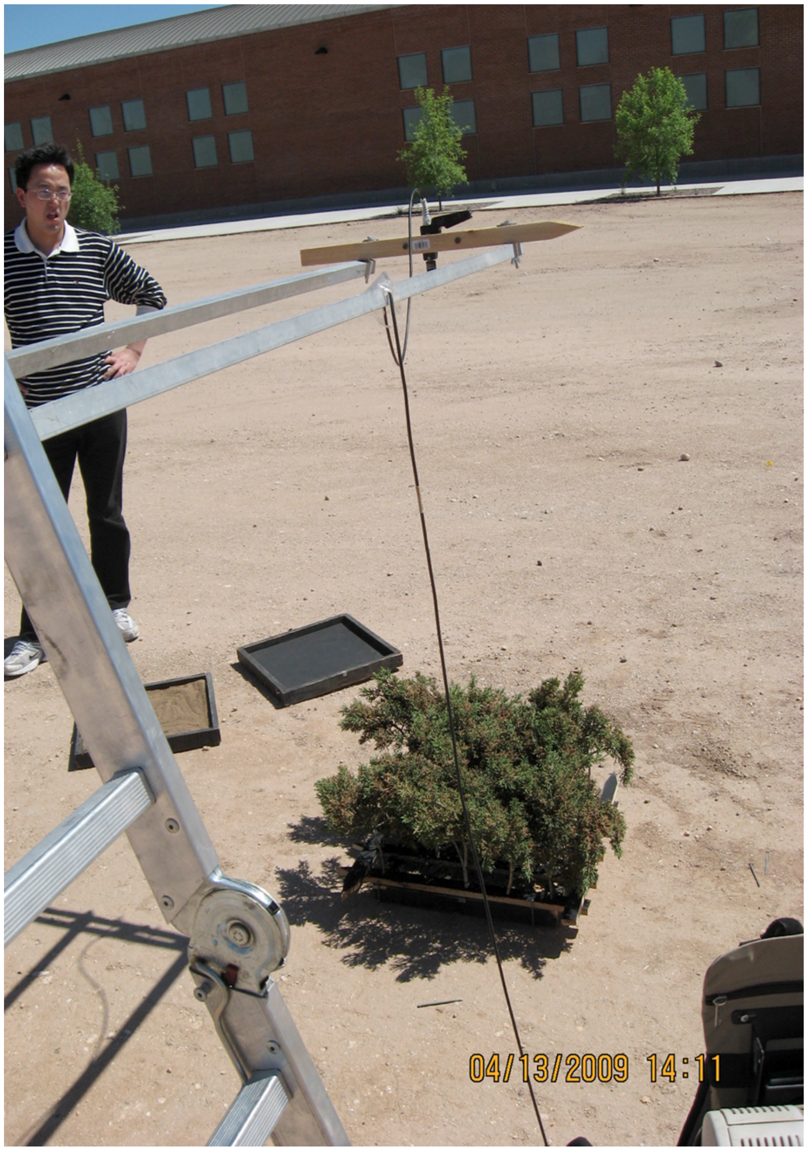
Juniper density* distribution over USA




04/13/2009 14:11

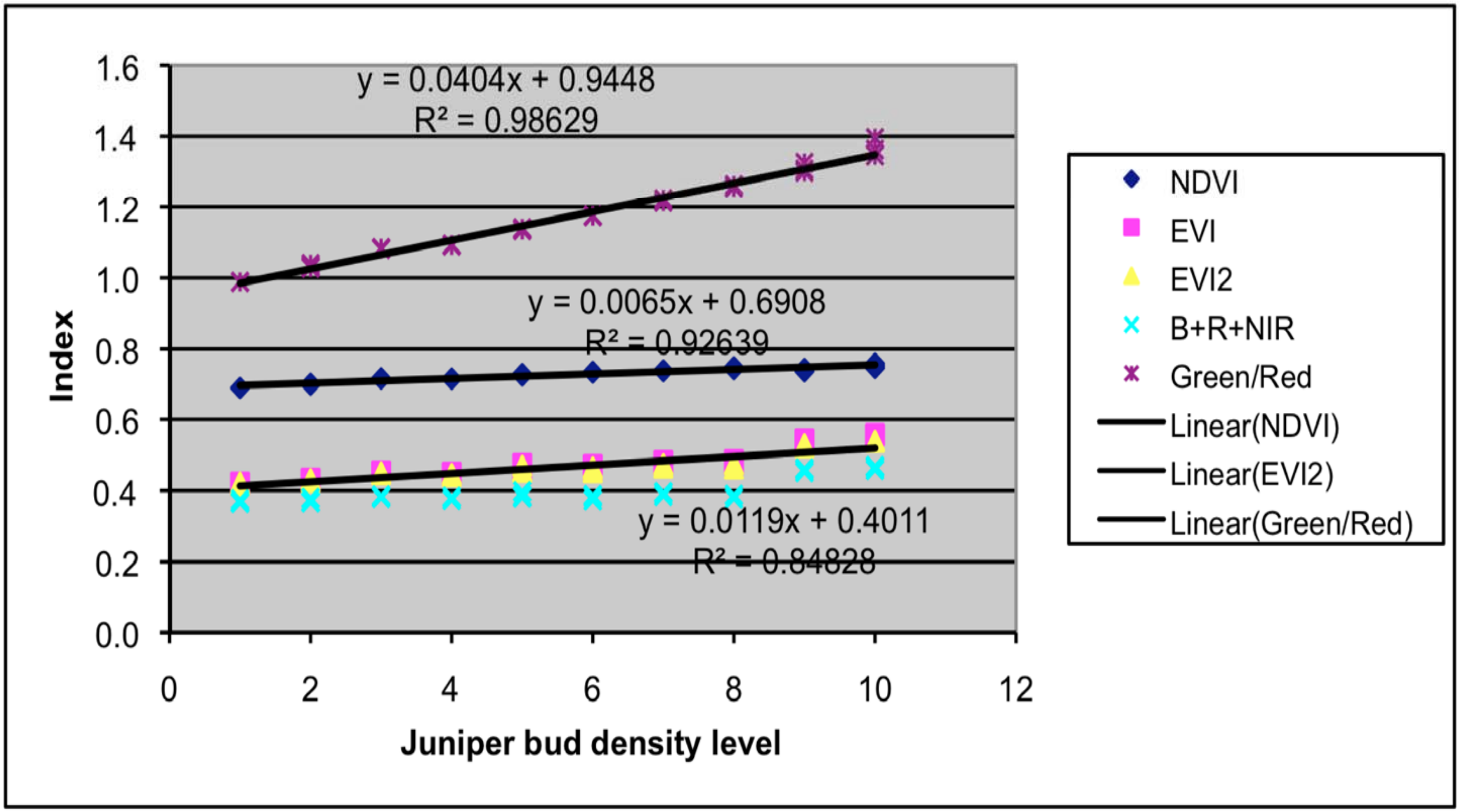

04/13/2009 15:05

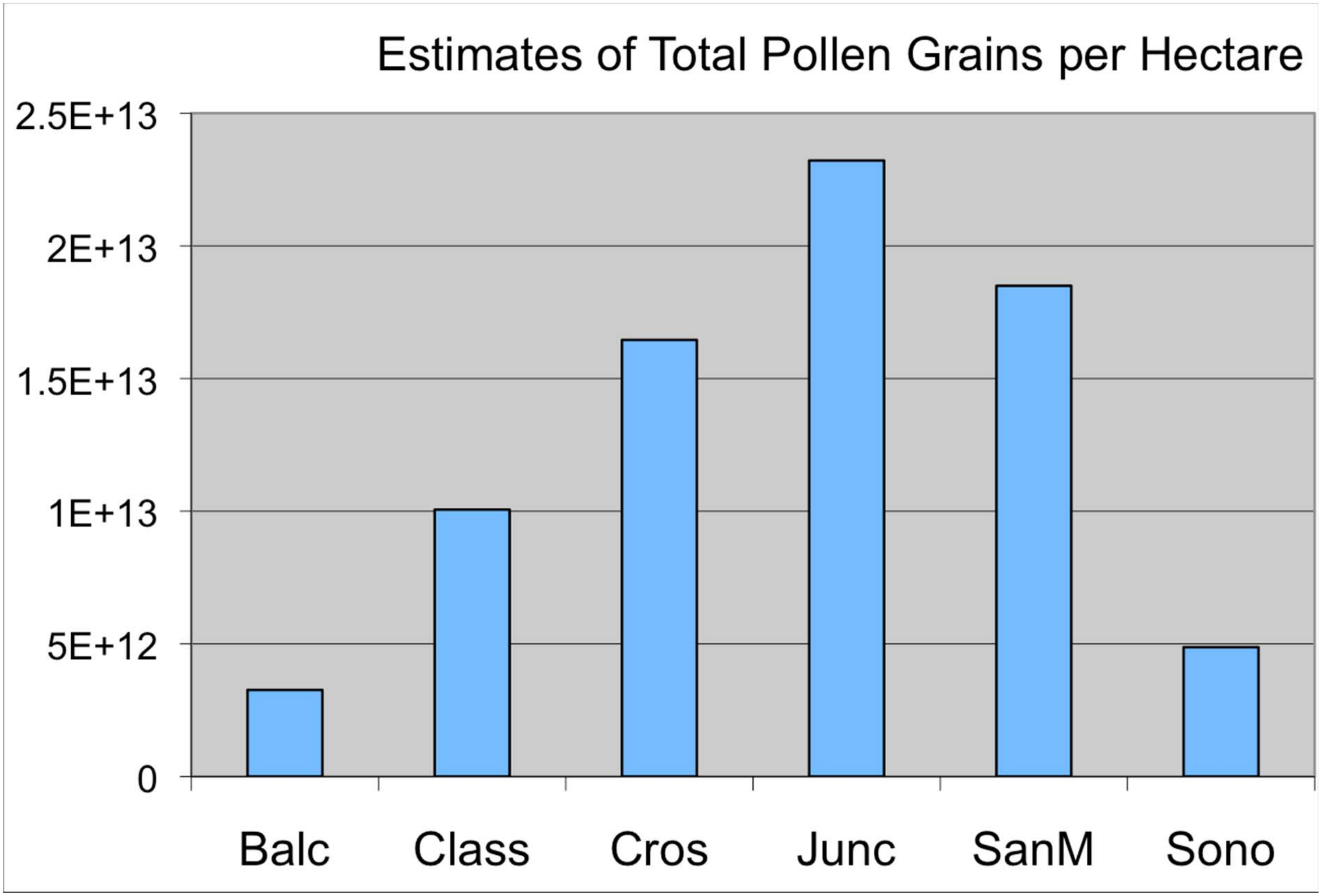
Spectral characteristics of male juniper canopies at different bud density levels



Density level	Bud density (g/m^2)
1	204.2
2	190.0
3	176.9
4	164.9
5	151.1
6	136.2
7	115.8
8	92.9
9	45.9
10	0.0

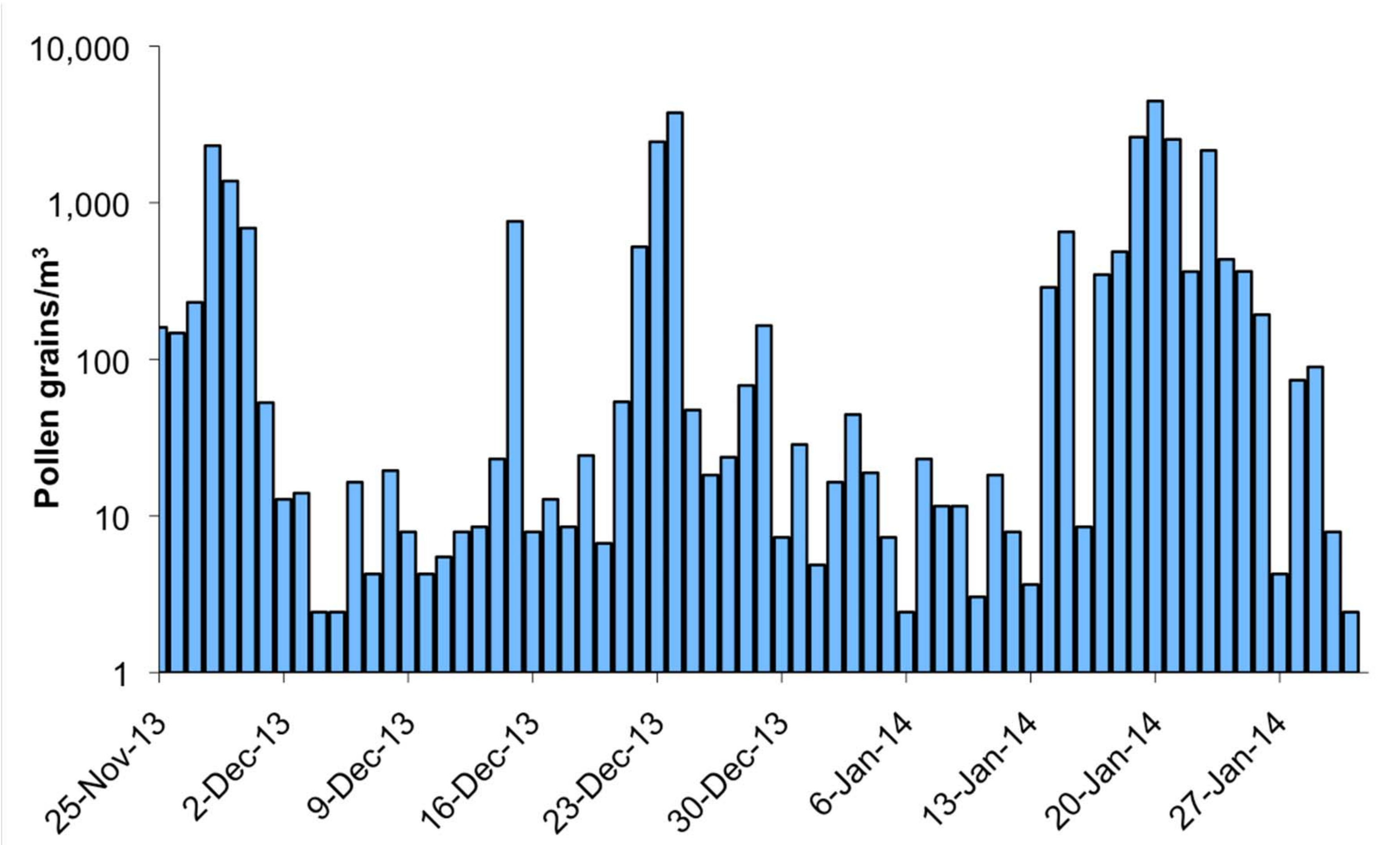
Relationships between spectral indices and juniper bud density levels





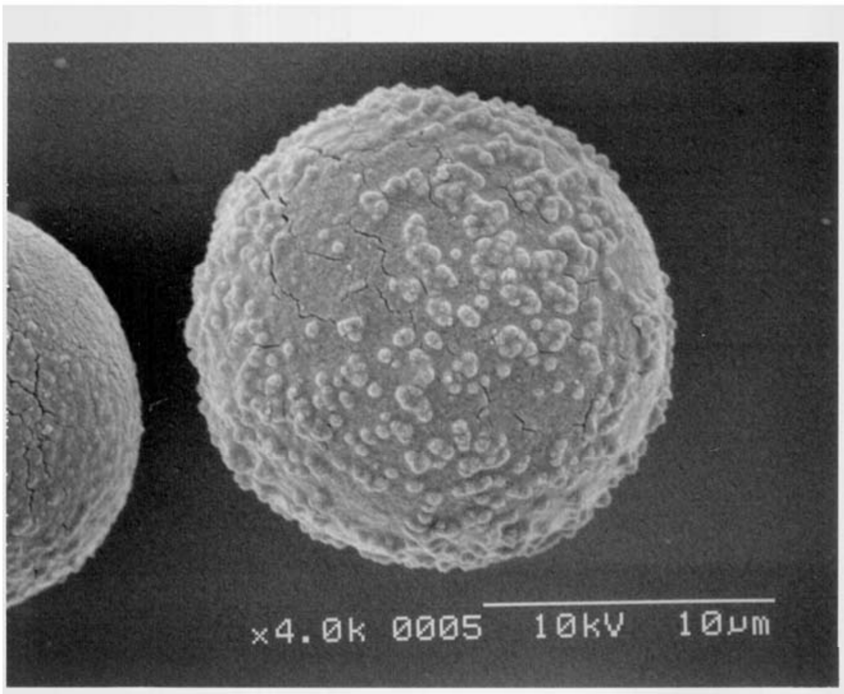
Estimates of Total Pollen Grains per Hectare
2.5E+13
2E+13
1.5E+13
1E+13
5E+12
0
Balc
Class
Cros
Junc
SanM
Sono

Mean Daily Concentration* of Airborne *Juniperus ashei* Pollen at Camp Classen, Davis, OK



*Concentration for each day is the mean of 12 bihourly concentrations

Juniper Pollen



Juniperus virginiana

<u>Good News for Modeling</u>

- Pollination Feb-March, little confusion with other pollinating plants
- *Juniperus* pollens are (mostly) spherical
- Distinct, large, 2-week pollination events: 2006 & 2007

Airborne Dust Simulations and Forecasts

University of Arizona

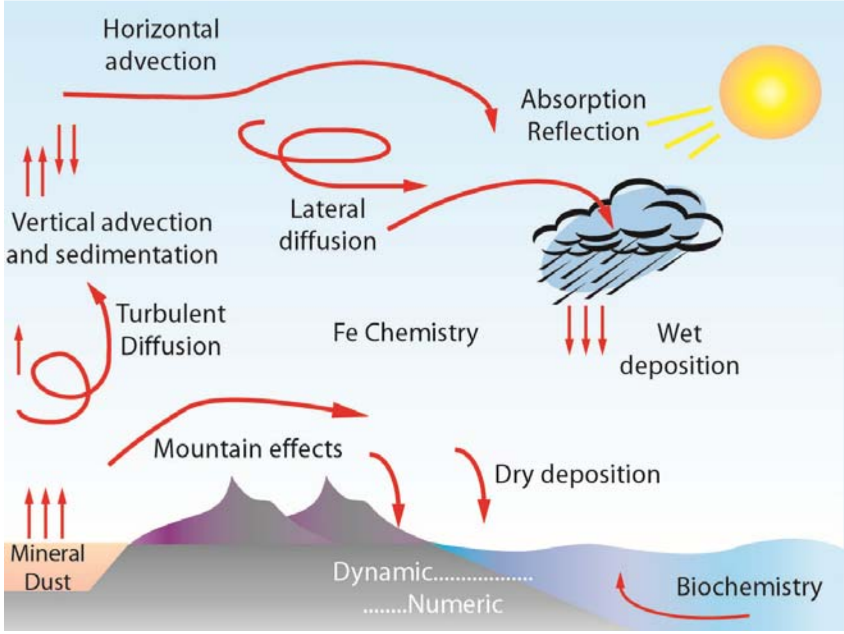
With NASA Earth System Science & University of New Mexico

Department of Atmospheric Sciences

http://www.atmo.arizona.edu/faculty/research/dust/dust.html

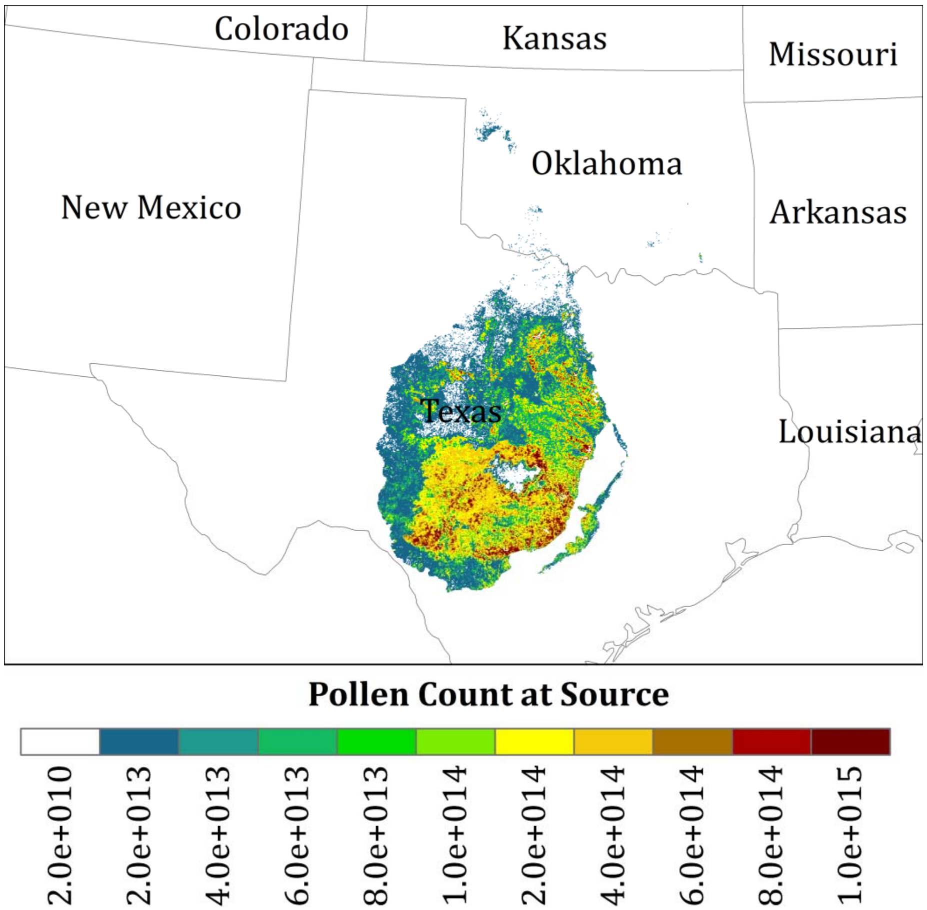
DREAM 4-8 particle bins

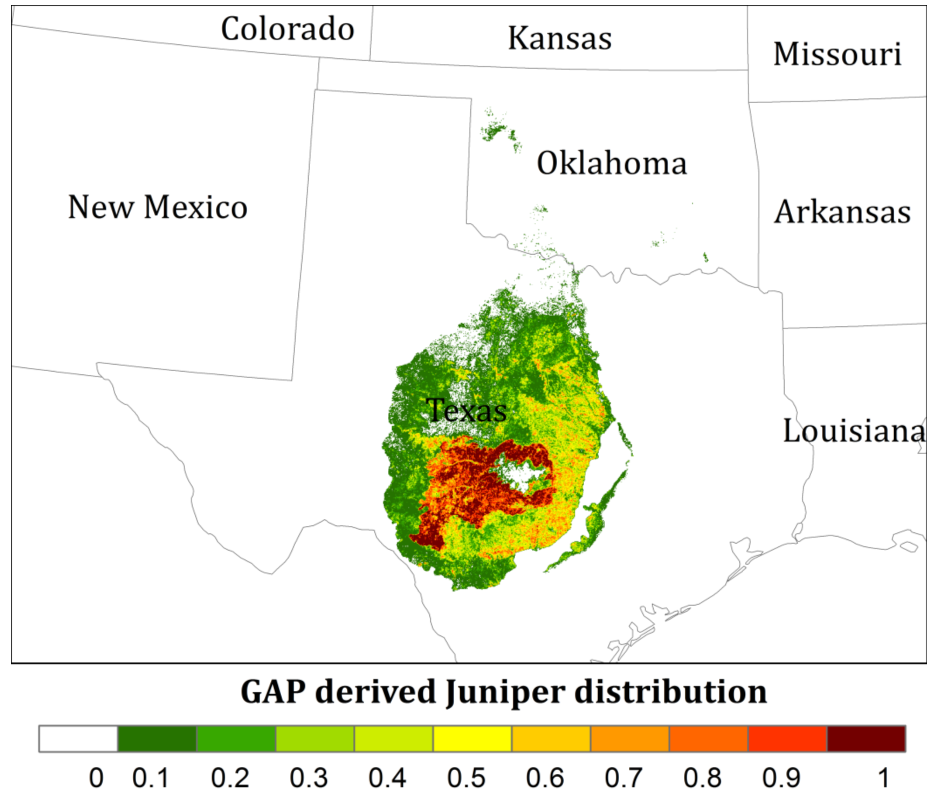
- **Model predictions (72-h):**
- Horizontal distribution
  - Surface concentration
  - Total column mass (dust load)
  - Wet, dry, total deposition
  - Meteorological variables
- Vertical distribution
  - Concentration
  - Cross sections
  - Fixed point/time profiles
- Fixed point (selected sites/cities)



Juniper Ashei

December to January





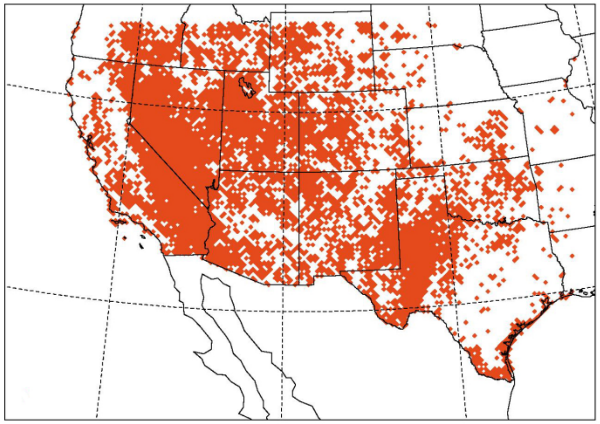
Pollen Count at Source

Distribution from GAP

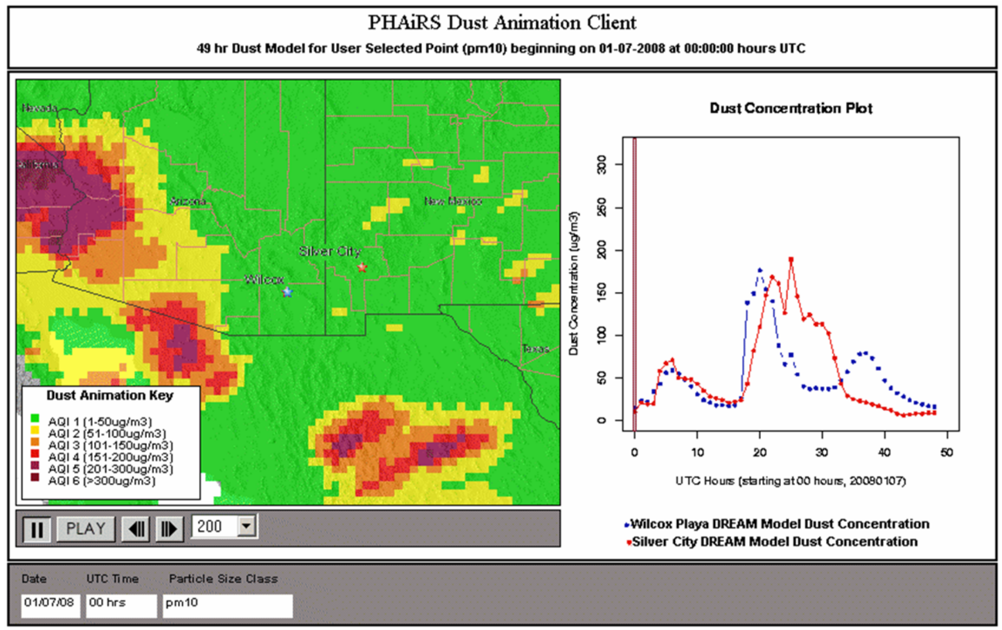
Grid resolution is ~1 km (990 m)

Phenology and Pollen Transport

NASA Remote Sensing



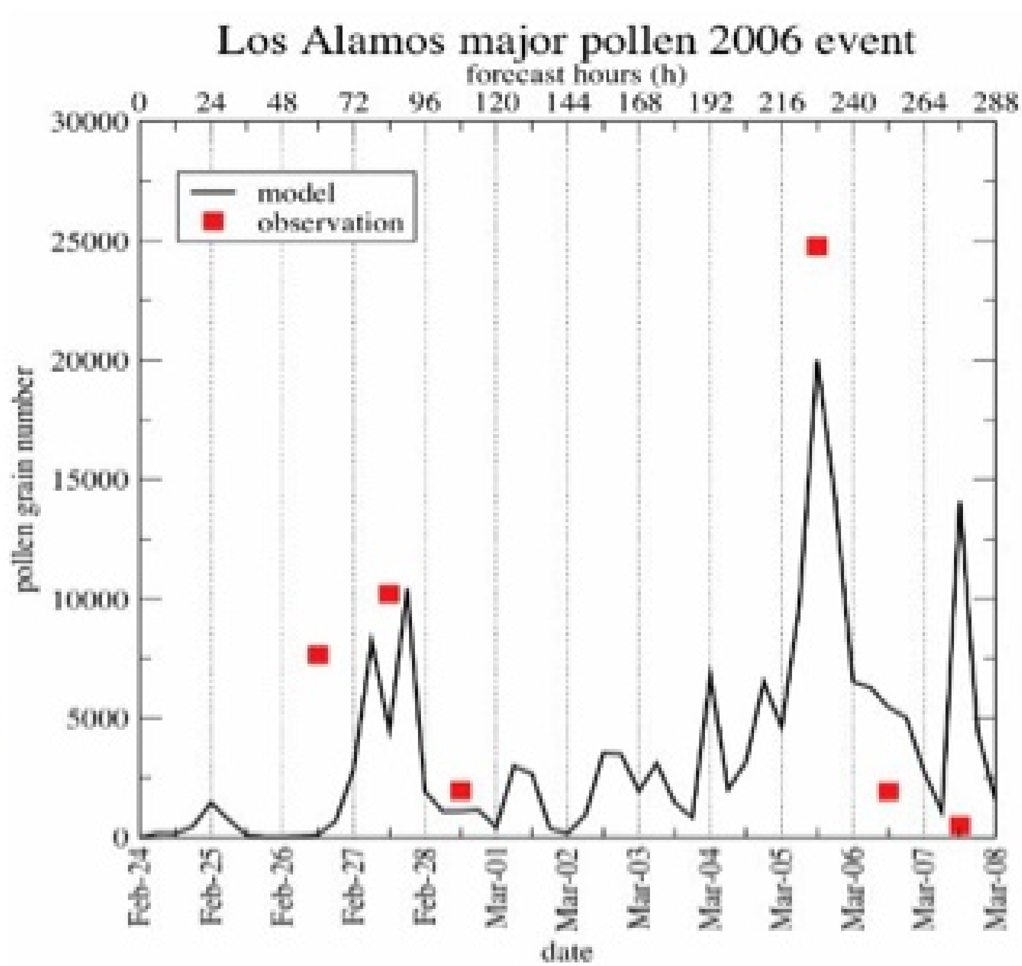
Currently – dust source regions
Future – pollen sources derived from **phenological** maps



Final Product – predicted concentrations of pollen in time and space

http://www.atmo.arizona.edu/research/dust/dust.html

DREAM (Dust REgional Atmospheric Model) – as -- **PREAM** (Phenology REgional Atmospheric Model)



CDC and New Mexico EPHTS

<u>**Health outcome data:**</u>

asthma

linkage **linkage**

<u>**Air quality data:**</u>

pollen counts

New Mexico EPHT Application Home | Log Out | Data Discovery | Graphs | Mapping Applications

NM Tracking Home

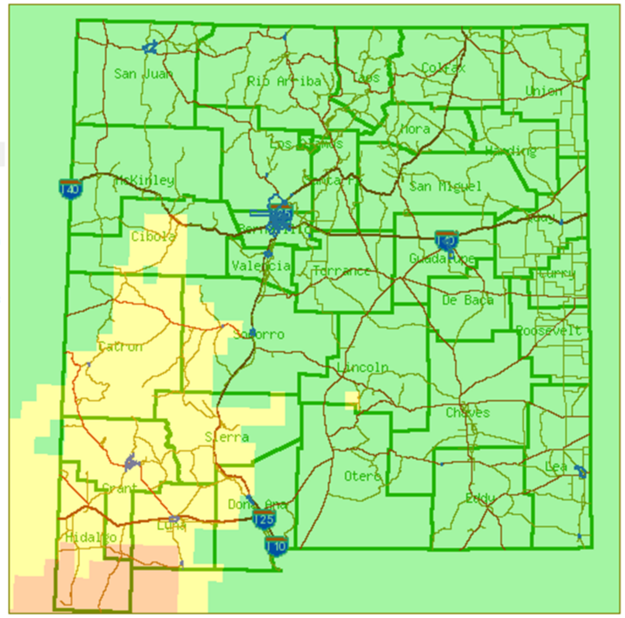
Welcome to the New Mexico EPHT Mapping Applications Page

How to use this map

The layers that you have requested to map are listed below. To add them to the map click 'add to map'. When you first add your EPHT query layer it will appear above the other layers in your map. You can use the arrowed buttons beside each layer in the table of contents to move layers up and down in the list for viewing. Navigation controls for the map are just below the map. Hovering over any of the controls gives you directions for their use. You must have popups enabled in your web browser in order to be able to query features in the map. You can use the small locator map above to zoom on the map in addition to using the zoom button below the map, just click and drag.

Map Layers from: your EPHT data search

DREAM dust output PM2.5 - Classified 24-Hr Mean 2009-04-11T00:00:00Z **add to map**



lon: lat:

Table of Contents

1 DREAM dust output PM2.5 - Classified 24-Hr Mean 2009-04-11T00:00:00Z

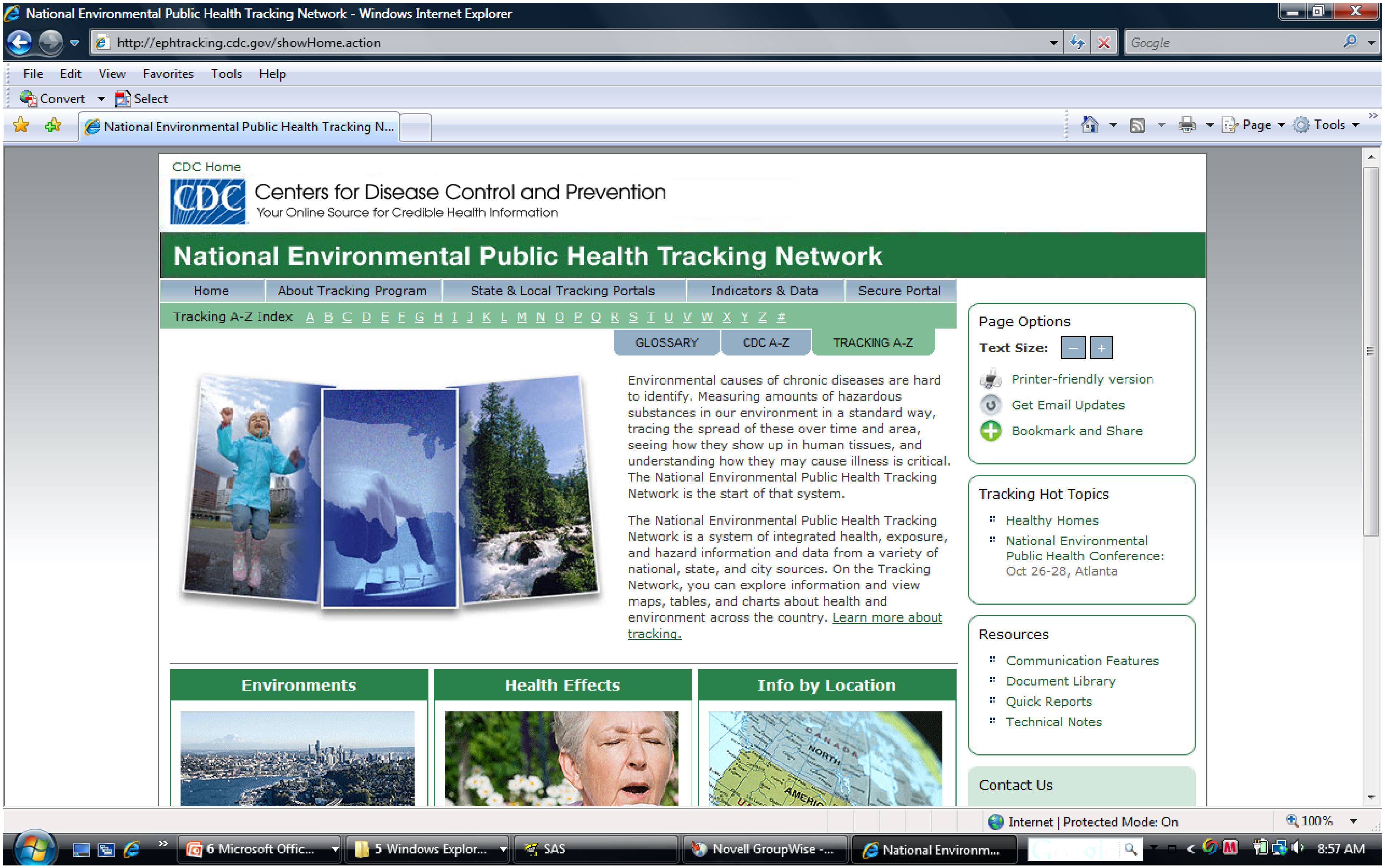
- Excellent
- Good
- Moderate
- Unhealthy for Sensitive Groups
- Unhealthy
- Very Unhealthy
- Hazardous

2 Water System Boundaries

Water System Boundaries

This portal was supported by Cooperative Agreement Number 5 U38EH000183 from the Centers for Disease Control and Prevention. Its contents are solely the responsibility of the authors (webmasters) and do not necessarily represent the official views of the Centers for Disease Control and Prevention.

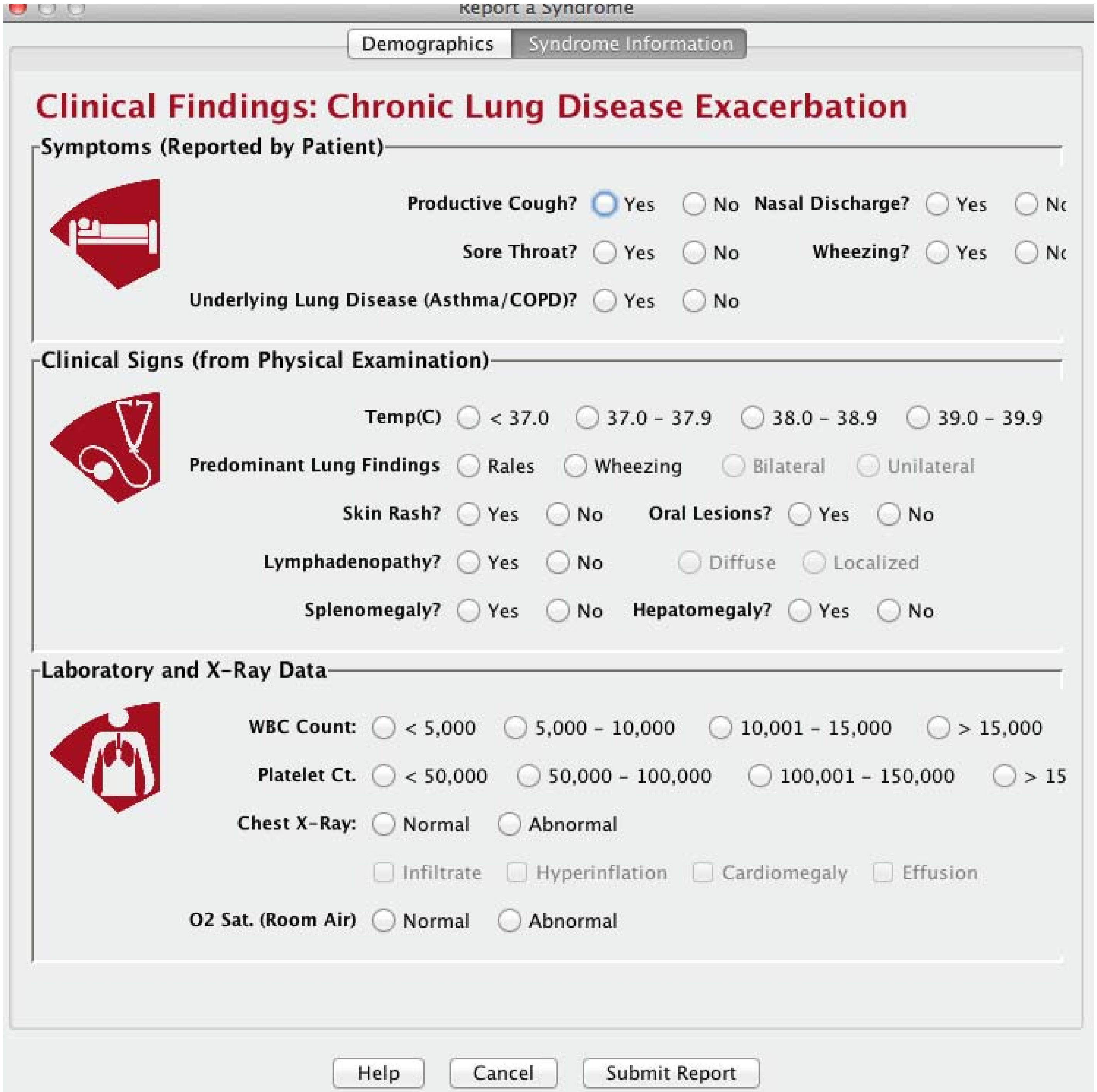
ephtracking.cdc.gov

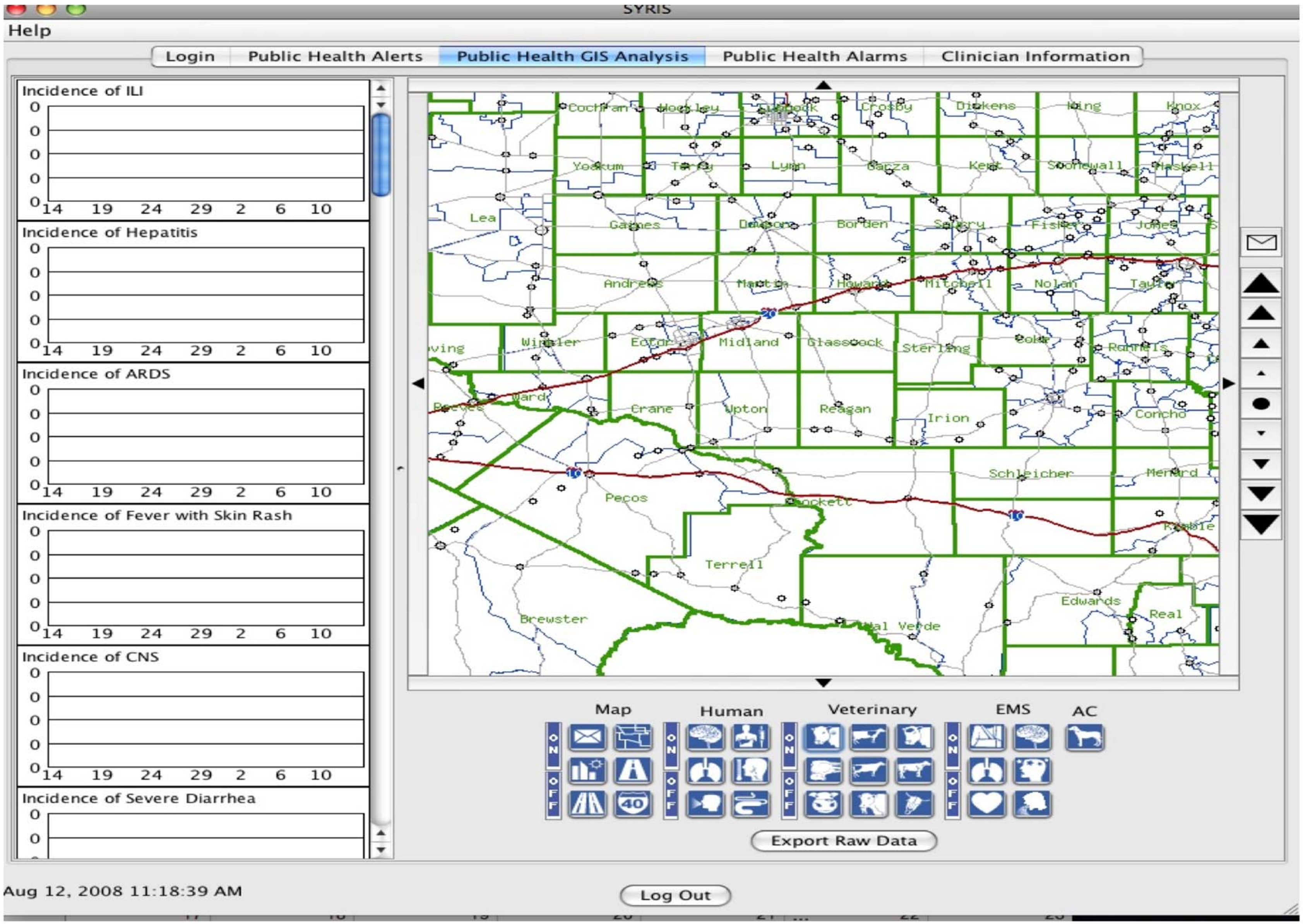


Syndrome Reporting Information System™

The SYRIS system provides:

- Real-time, Syndrome-Based Reporting Tool
- 2-Way Real-time Communication System - 24/7
- Automated, Immediate 'Alerts' to Public Health Officials (PHO's)
- Health 'Alerts' to Vets, Doctors, Hospitals, & Schools
- Web-Based Tool for Easy Syndrome Entry and Communication
- Geographic Mapping of Disease Outbreaks
- Connects All Health Care Providers to a Common Database
- Instantaneous Geographic Mapping of Disease Outbreaks
- Full compliance with the requirements of Public Law 109-417 (the Pandemic and All-Hazards Preparedness Act)


Report a Syndrome
Demographics
Syndrome Information
Clinical Findings: Chronic Lung Disease Exacerbation
Symptoms (Reported by Patient)
Productive Cough? Yes No
Nasal Discharge? Yes No
Sore Throat? Yes No
Wheezing? Yes No
Underlying Lung Disease (Asthma/COPD)? Yes No
Clinical Signs (from Physical Examination)
Temp(C) < 37.0 37.0 – 37.9 38.0 – 38.9 39.0 – 39.9
Predominant Lung Findings Rales Wheezing Bilateral Unilateral
Skin Rash? Yes No
Oral Lesions? Yes No
Lymphadenopathy? Yes No Diffuse Localized
Splenomegaly? Yes No
Hepatomegaly? Yes No
Laboratory and X-Ray Data
WBC Count: < 5,000 5,000 – 10,000 10,001 – 15,000 > 15,000
Platelet Ct. < 50,000 50,000 – 100,000 100,001 – 150,000 > 15
Chest X-Ray: Normal Abnormal
Infiltrate Hyperinflation Cardiomegaly Effusion
O2 Sat. (Room Air) Normal Abnormal
Help
Cancel
Submit Report



SYRIS will be used by Public Health Officials for interactive display of PREAM pollen maps, syndrome reporting and alerts

USA npn National Phenology Network

A new data resource—*a national network of integrated phenological observations across space and time*

<u>Key Goal</u>

Understand how plants, animals and landscapes respond to environmental variation and climate change

USA npn National Phenology Network

Taking the Pulse of Our Planet

Log In

ABOUT | PARTICIPATE | RESOURCES | EDUCATION | RESULTS | ARCHIVE

Search Site | search

western columbine

View All Species

Join Us!

We are looking for volunteers to help us monitor plant and animal species found across the United States. Click "Observe" to join us!

Observe

Featured Projects

1 of 2 ››

Sponsors

USA National Phenology Network

The USA National Phenology Network brings together citizen scientists, government agencies, non-profit groups, educators and students of all ages to monitor the impacts of climate change on plants and animals in the United States. The network harnesses the power of people and the Internet to collect and share information, providing researchers with far more data than they could collect alone.

Learn more about us

What is phenology?

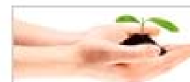
Phenology refers to recurring plant and animal life cycle stages, or phenophases, such as leafing and flowering, maturation of agricultural plants, emergence of insects, and migration of birds. Many of these events are sensitive to climatic variation and change, and are simple to observe and record. As an USA-NPN observer, you can help scientists identify and understand environmental trends so we can better adapt to climate change.

Why is phenology important?

USA-NPN News | **Phenology Feed** | **Join the Conversation**

- Phenoclimatology Position at UA
- Introducing the USA-NPN Video
- ***Nature's Notebook:*** "How to Observe" Handbook and Training Videos
- Phenology Special Issue in the Philosophical Transactions of the Royal Society
- USA-NPN Reports (including Strategic Plan and 2009 Annual Report)
- Call for Papers: 4th Annual PROSE in Tucson, AZ, October 2010

- Recent Media Reports
- Newsletter Archive



Are you...?

New to phenology?

Ready to start observing?

One of our partners?

Interested in creating a partnership?

An educator?

Interested in finding data to use?

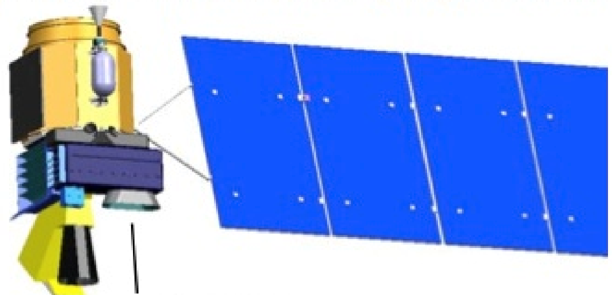
A media outlet?

USA National Phenology Network, National Coordinating Office
1955 E. Sixth St., Tucson, AZ 85721

September 05 2008

NRC Decadal Survey HyspIRI

Visible ShortWave InfraRed (VSWIR) Imaging Spectrometer
+
Multispectral Thermal InfraRed (TIR) Scanner

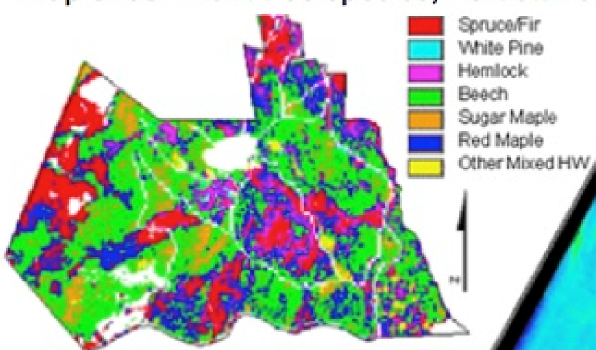


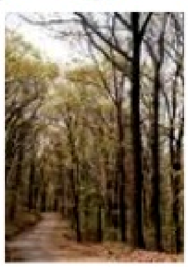
Charts by JPL/Rob Green & Simon Hook

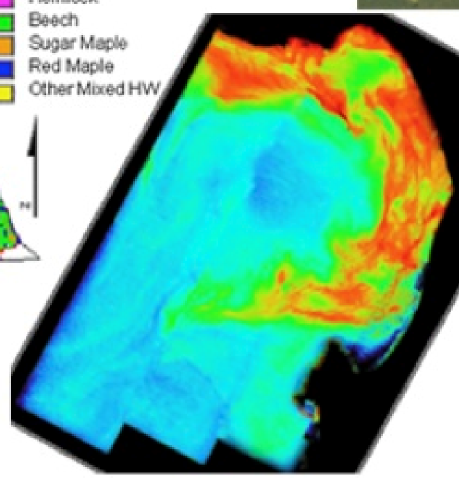
VSWIR: Plant Physiology and Function Types (PPFT)

Multispectral TIR Scanner

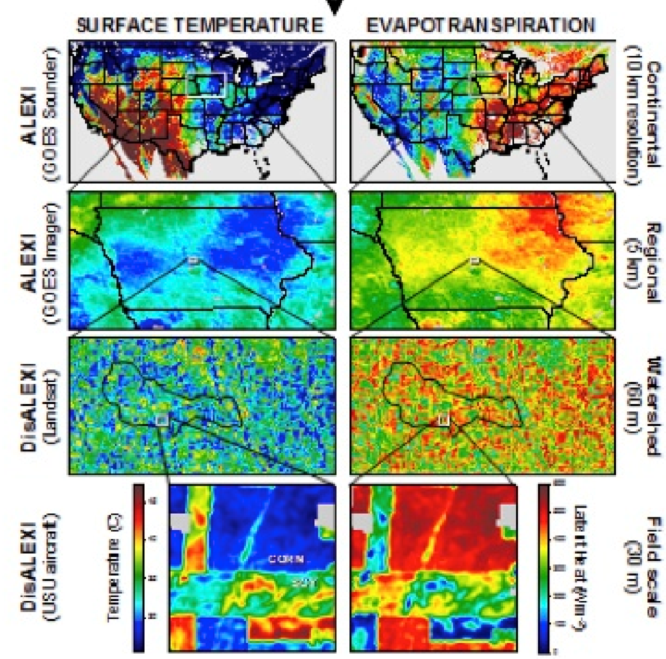
Map of dominant tree species, Bartlett Forest, NH







Red tide algal bloom in Monterey Bay, CA



HYSPIRI SCIENCE AND APPLICATIONS

Dr Simon J. Hook
Jet Propulsion Laboratory, California Institute of Technology.

With contributions from:
Elizabeth Middleton
Robert O Green

HyspIRI and the NRC Decadal Survey

- January 2007: NRC releases Earth Science & Applications from Space report (the Decadal Survey) to NASA, NOAA, & USGS
- Calls for 17 satellite missions as an integrated set of

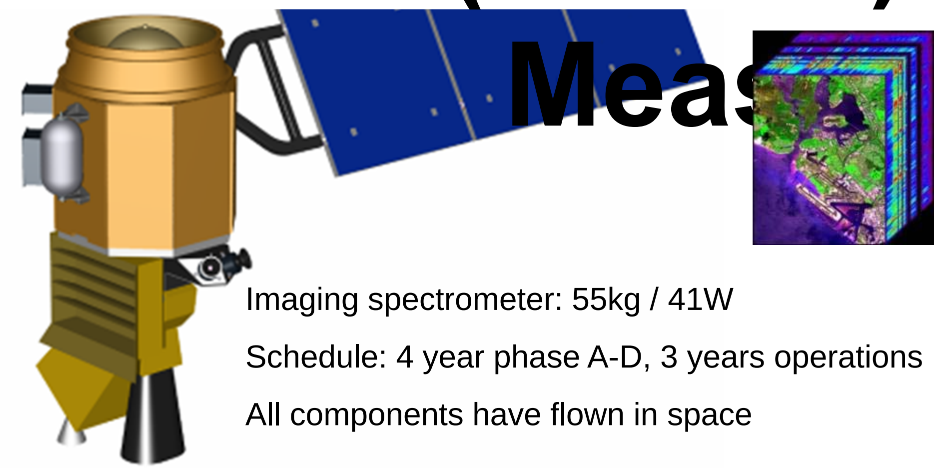
VSWIR Overarching Science Questions

- **VQ1. Pattern and Spatial Distribution of Ecosystems and their Components, (EM,JG)**
  - What is the pattern of ecosystem distribution and how do ecosystems differ in their composition or biodiversity? [DS 195]
- **VQ2. Ecosystem Function, Physiology and Seasonal Activity, (EM,JG)**
  - What are the seasonal expressions and cycles for terrestrial and aquatic ecosystems, functional groups and diagnostic species? How are these being altered by changes in climate, land use, and disturbances? [DS 191, 195, 203]
- **VQ3. Biogeochemical Cycles (SO, SU)**
  - How are biogeochemical cycles for carbon, water and nutrients being altered by natural and human-induced environmental changes?
- **VQ4. Changes in Disturbance Activity (RK,GA)**
  - How are disturbance regimes changing and how do these changes affect the ecosystem processes that support life on Earth?
- **VQ5. Ecosystem and Human Health, (PT,GG)**
  - How do changes in ecosystem composition and function affect human health, resource use, and resource management?
- **VQ6. Land Surface and Shallow Water Substrate Composition (RG, HD)**
  - What is the land surface soil/rock and shallow water substrate composition?

TIR Overarching Science Questions

- **TQ1. Volcanoes/Earthquakes (MA,FF)**
  - How can we help predict and mitigate earthquake and volcanic hazards through detection of transient thermal phenomena?
- **TQ2. Wildfires (LG,DR)**
  - What is the impact of global biomass burning on the terrestrial biosphere and atmosphere, and how is this impact changing over time?
- **TQ3. Water Use and Availability, (MA,RA)**
  - How is consumptive use of global freshwater supplies responding to changes in climate and demand, and what are the implications for sustainable management of water resources?
- **TQ4. Urbanization/Human Health, (DQ,GG)**
  - How does urbanization affect the local, regional and global environment? Can we characterize this effect to help mitigate its impact on human health and welfare?
- **TQ5. Earth surface composition and change, (AP,JC)**
  - What is the composition and temperature of the exposed surface of the Earth? How do these factors change over time and affect land use and habitability?

Shortwave Infrared (VSWIR) Science Measurements



Imaging spectrometer: 55kg / 41W

Schedule: 4 year phase A-D, 3 years operations

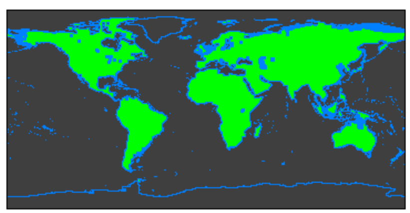
All components have flown in space

Science Questions:

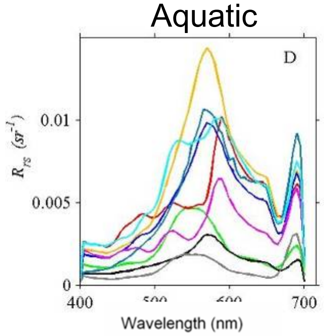
- *What is the composition, function, and health of land and water ecosystems?*
- *How are these ecosystems being altered by human activities and natural causes?*
- *How do these changes affect fundamental ecosystem processes upon which life on Earth depends?*

Measurement:

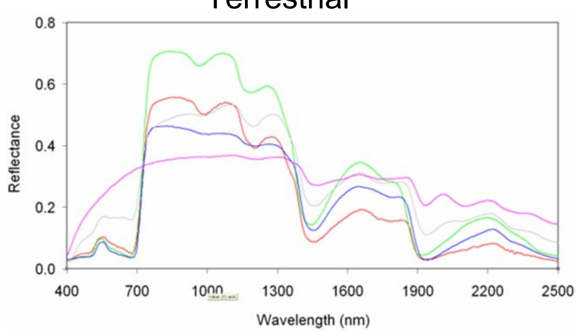
- 380 to 2500 nm in 10nm channels
- Accurate 60 m sampling
- 19 days revisit mapping mission
- Global land and shallow water



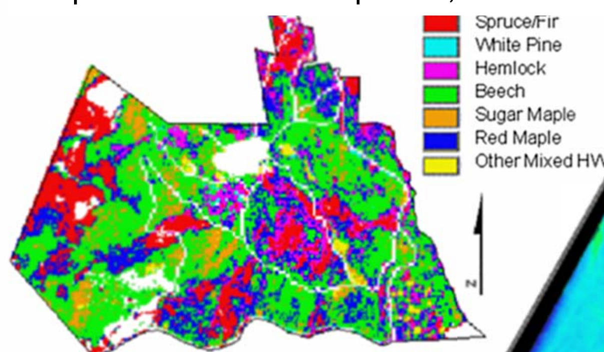
Aquatic

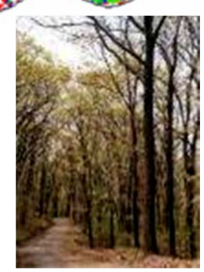


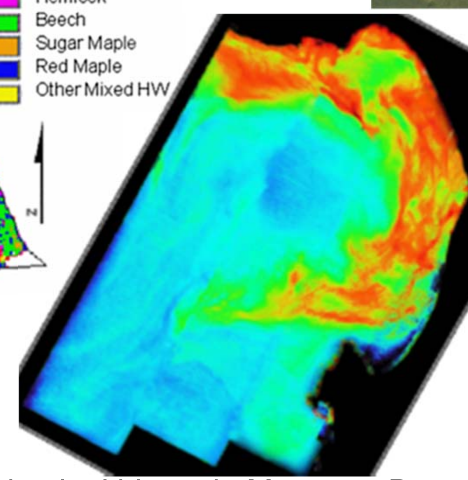
Terrestrial



Map of dominant tree species, Bartlett Forest, NH

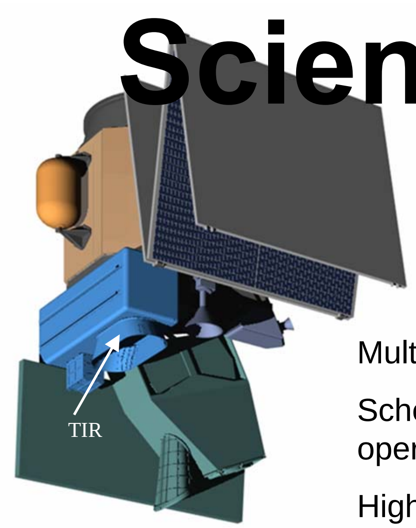


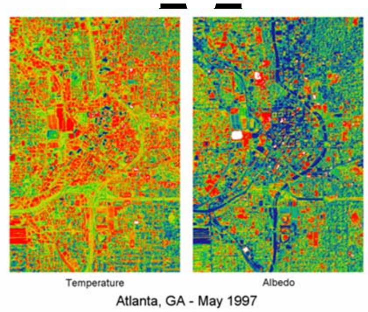




Red tide algal bloom in Monterey Bay, CA

HyspIRI Thermal Infrared Multispectral (TIR) Science Measurements





Multispectral Scanner: 60kg / 103W

Schedule: 4 year phase A-D, 3 years operations

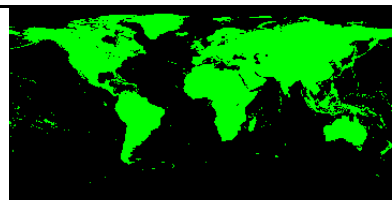
High Heritage

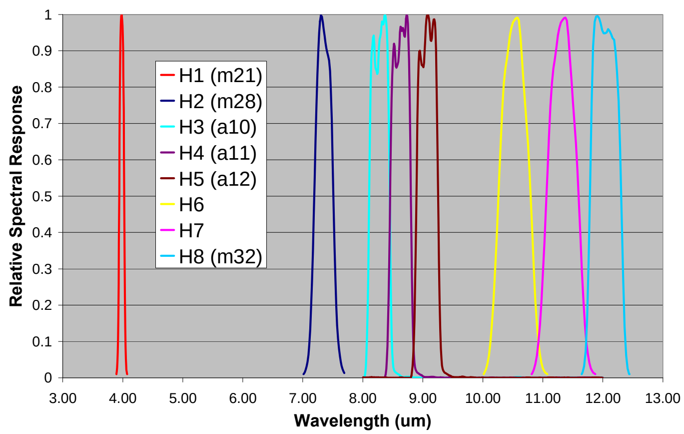
Science Questions:

• TQ1. Volcanoes/Earthquakes (MA,FP)
– How can we help predict and mitigate earthquake and volcanic hazards through detection of transient thermal phenomena?
• TQ2. Wildfires (LG,DR)
– What is the impact of global biomass burning on the terrestrial biosphere and atmosphere, and how is this impact changing over time?
• TQ3. Water Use and Availability, (MA,RA)
– How is consumptive use of global freshwater supplies responding to changes in climate and demand, and what are the implications for sustainable management of water resources?
• TQ4. Urbanization/Human Health, (DQ,GG)
– How does urbanization affect the local, regional and global environment? Can we characterize this effect to help mitigate its impact on human health and welfare?
• TQ5. Earth surface composition and change, (AP,JC)
– What is the composition and temperature of the exposed surface of the Earth? How do these factors change over time and affect land use and habitability?

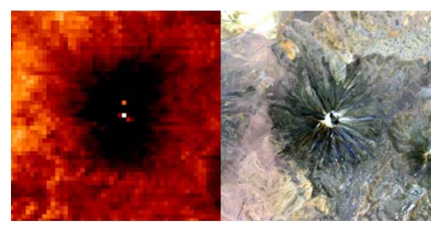
Measurement:

- 7 bands between 7.5-12 µm and 1 band at 4 µm
- 60 m resolution, 5 days revisit
- Global land and shallow water



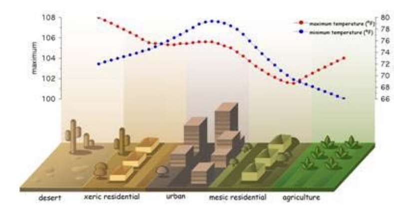


Andean volcano heats up

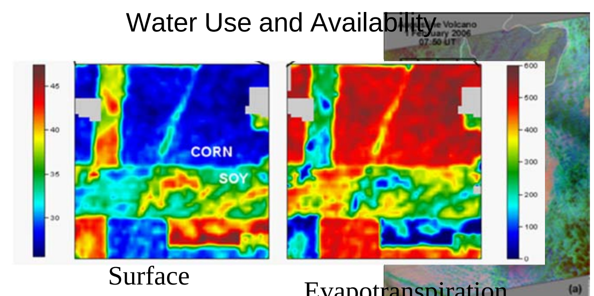


Volcanoes

Urbanization



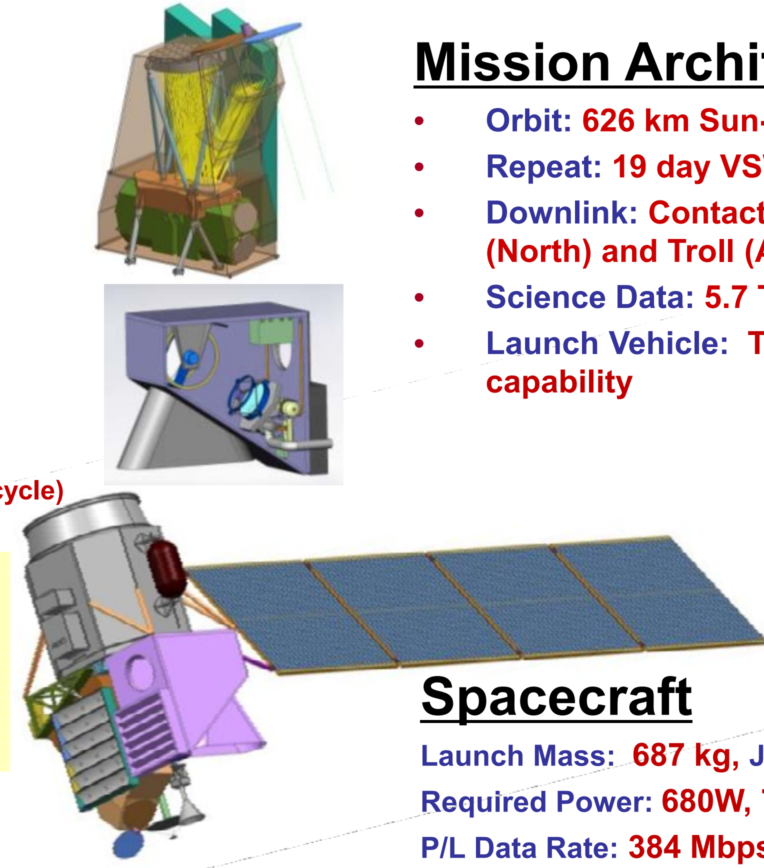
Water Use and Availability



Surface Temperature

Evapotranspiration

HyspIRI Mission Concept - 2010



Payload

Science Instruments:

- VSWIR: Imaging Spectrometer
  - 380-2500 nm in 10 nm bands
  - 60m spatial resolution
  - Day-side (23% duty cycle)
  - 55 Kg, 41 W
- TIR: Thermal Infrared Scanner
  - 8 bands between 3-12 μm
  - 60m spatial resolution
  - Day and night-side (100% duty cycle)
  - 60 Kg, 103 W

Intelligent Payload Module (IPM)

- 24/7 Direct Broadcast capability
- subset of science data
- X-band @ 20 Mbps
- 11 Kg, 86 W

Implementation

Launch Date: 2014 - 2020

Lifetime: 3 years, with consumables for 5

Cost : Low to Moderate cost Mission

Partners: JPL, GSFC

Mission Class: C, with selected redundancy

Hardware Model: Protoflight

Mission Architecture

- Orbit: 626 km Sun-Synchronous, 10:30am LTDN
- Repeat: 19 day VSWIR / 5 day TIR
- Downlink: Contacts nearly every orbit to Svalbard (North) and Troll (Antarctica)
- Science Data: 5.7 Tbits/day
- Launch Vehicle: Taurus 3210, 2m fairing, 790 kg capability

Spacecraft

Launch Mass: 687 kg, JPL DP Margin: 30%

Required Power: 680W, 7.1 m^2 array (965 W capability)

P/L Data Rate: 384 Mbps

Downlink Data Rate: 800 Mbps Dual-pol X-band

Stabilization: 3-axis

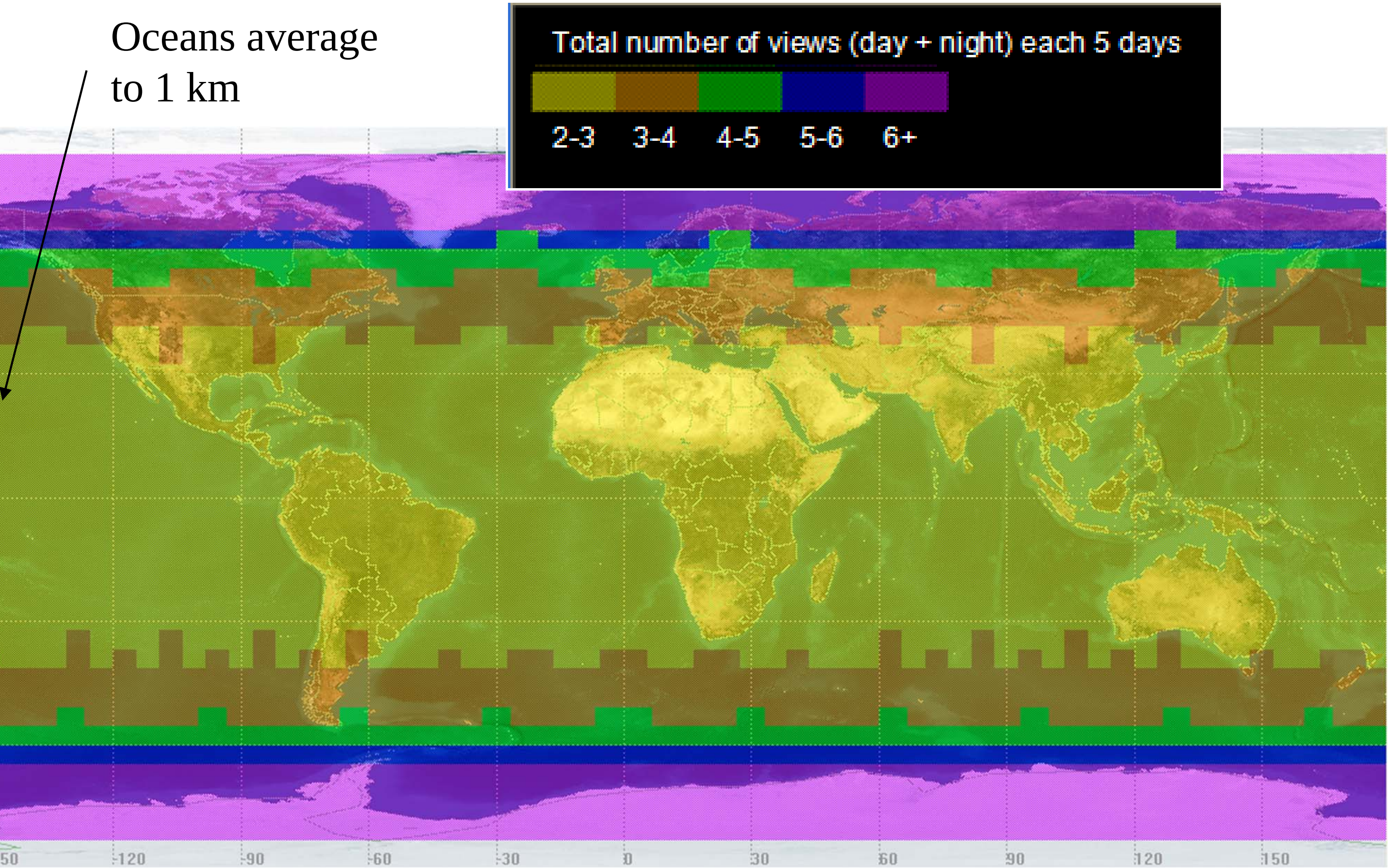
Pointing: Control =720 arcsec (per axis 3σ)

Knowledge = 5.6 arcsec (Pitch/Roll axis 3σ);

15 arcsec (Yaw axis 3σ)

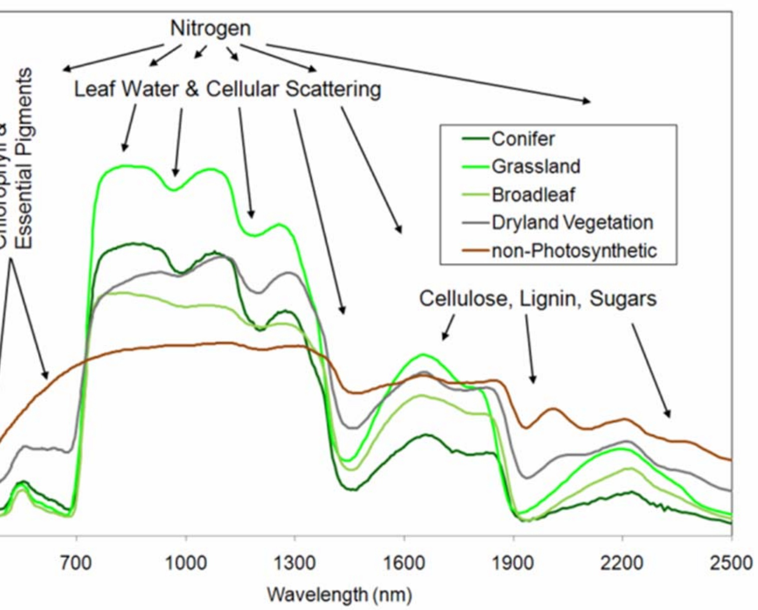
Stability = 5 arcsec/sec (per axis 3σ)

nual TIR imaging opportunities in a 5-day near-repeating orbit, 1 yr. simulation

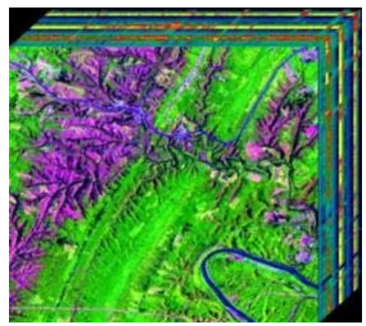


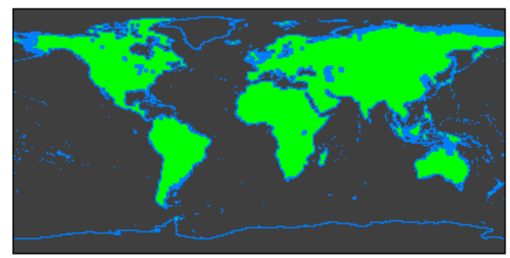
Ecosystem Measurements for Climate Feedbacks

Measuring the Terrestrial Biosphere

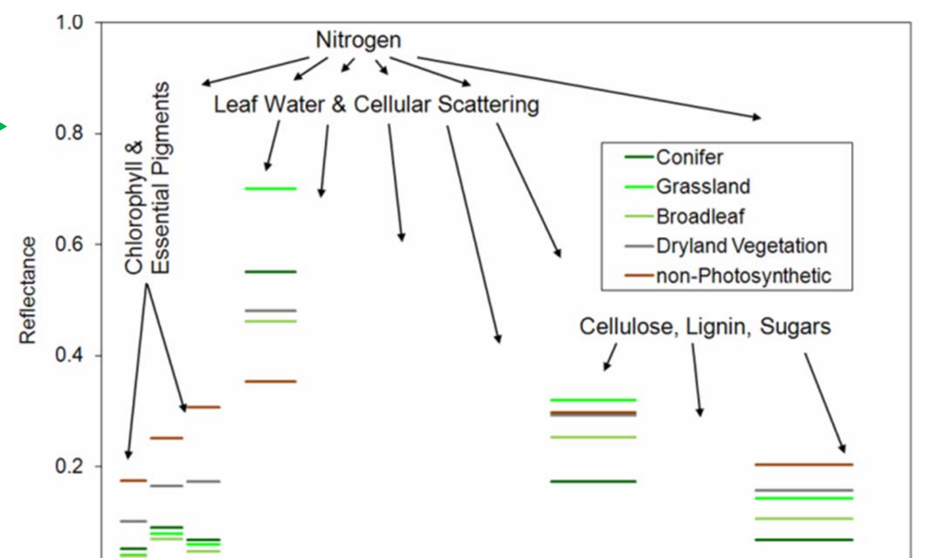


Imaging Spectroscopy is required to measure critical variables of the terrestrial biosphere.





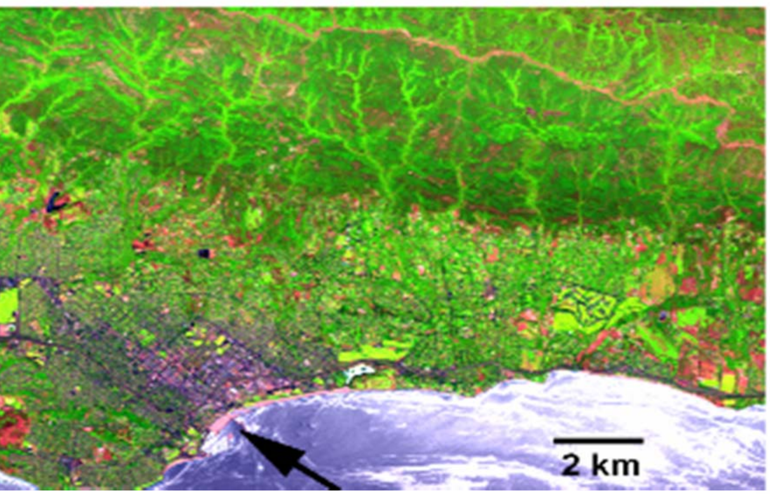
-spectral imaging is insufficient



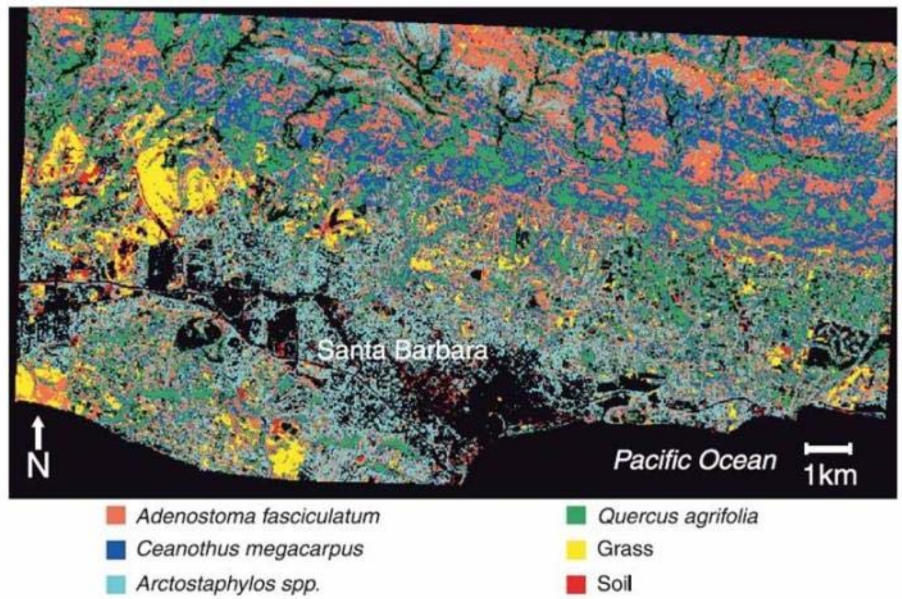
Ecosystem Measurements for Climate Feedbacks

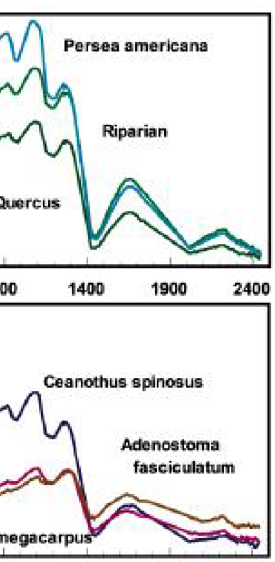
Vegetation Species/Functional-type & Fractional Cover

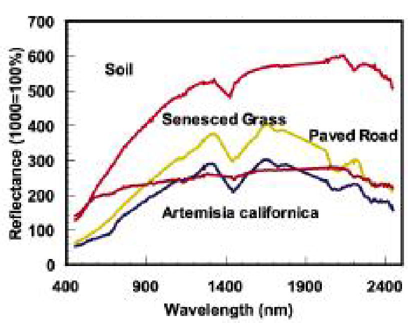
Santa Barbara, CA Coast Range



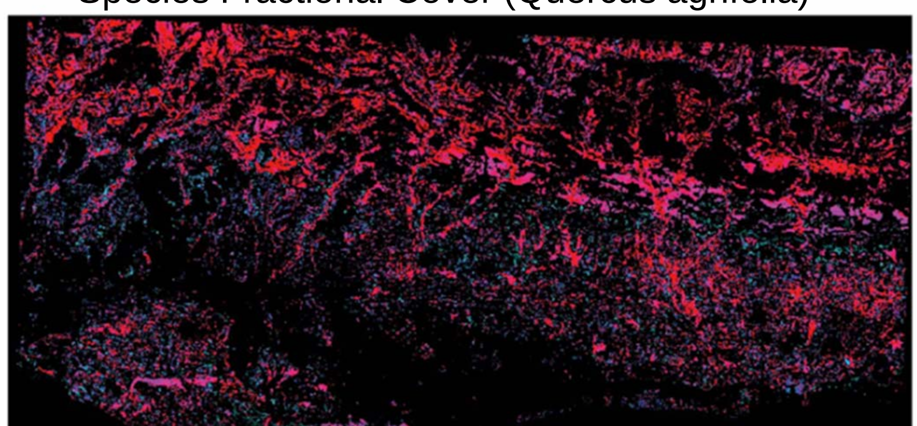
Species Type 90% accurate





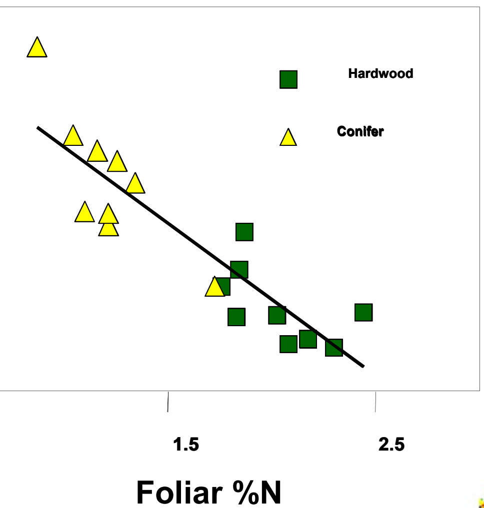


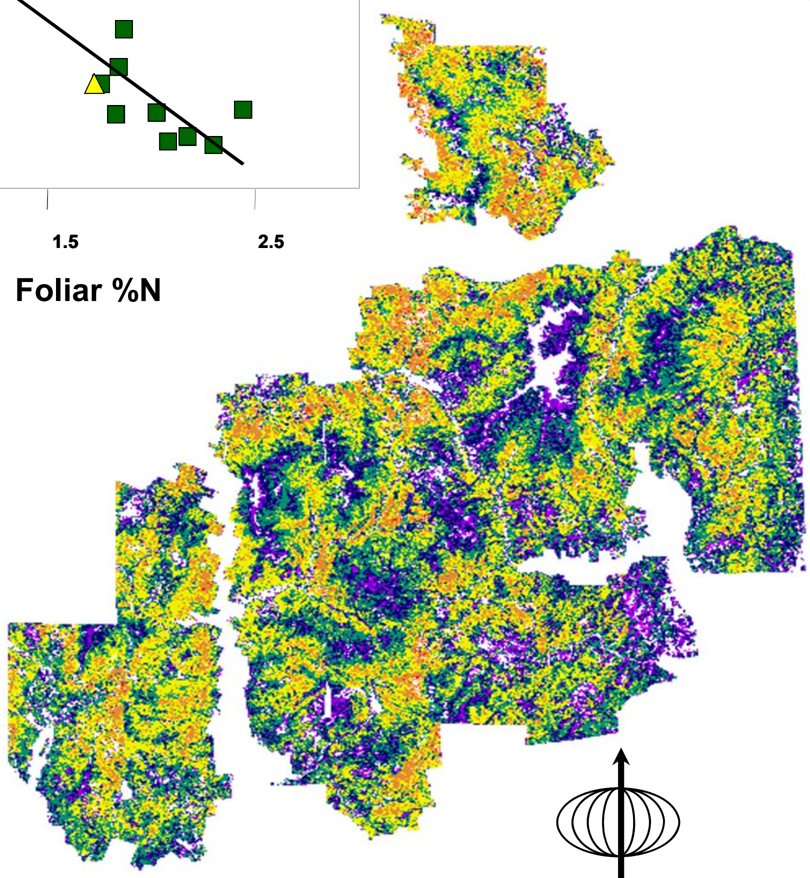
Species Fractional Cover (Quercus agrifolia)

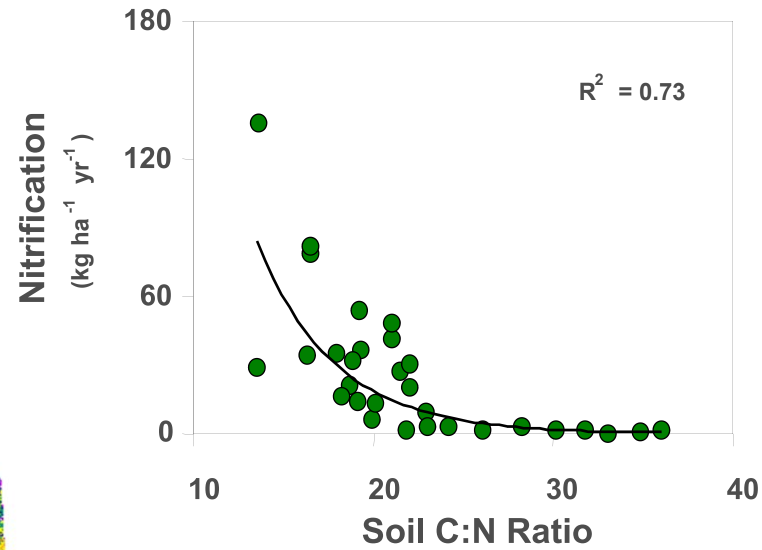


Ecosystem Measurements for Climate Feedbacks

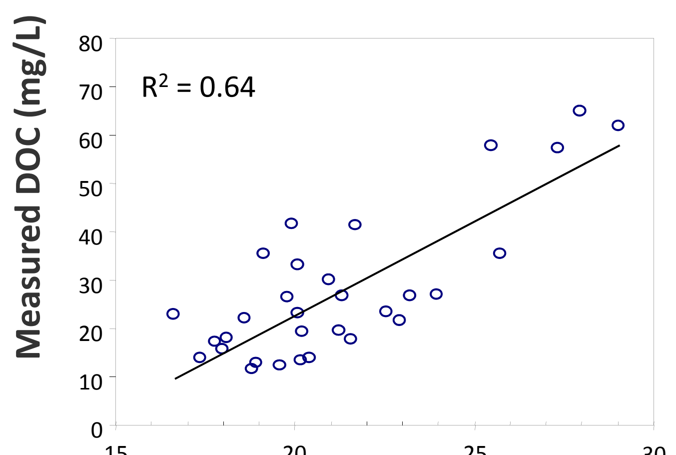
Imaging Spectroscopy Foliar Chemistry Used to Estimate Soil Nitrogen Cycling



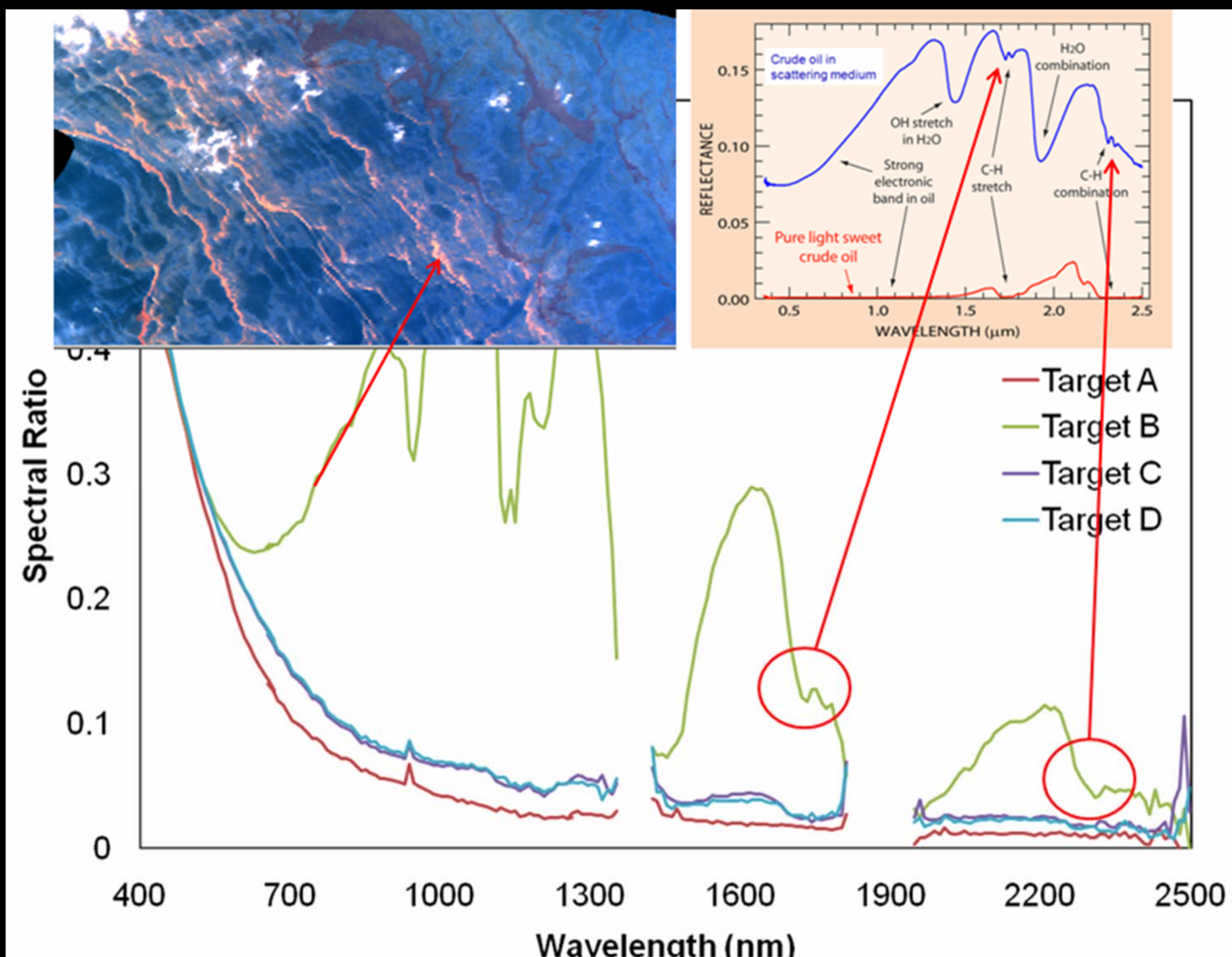




Predicted C:N versus Stream DOC



IS Measurements of Carbon-Hydrogen Bond Spectral Signature in Gulf Oil Spill

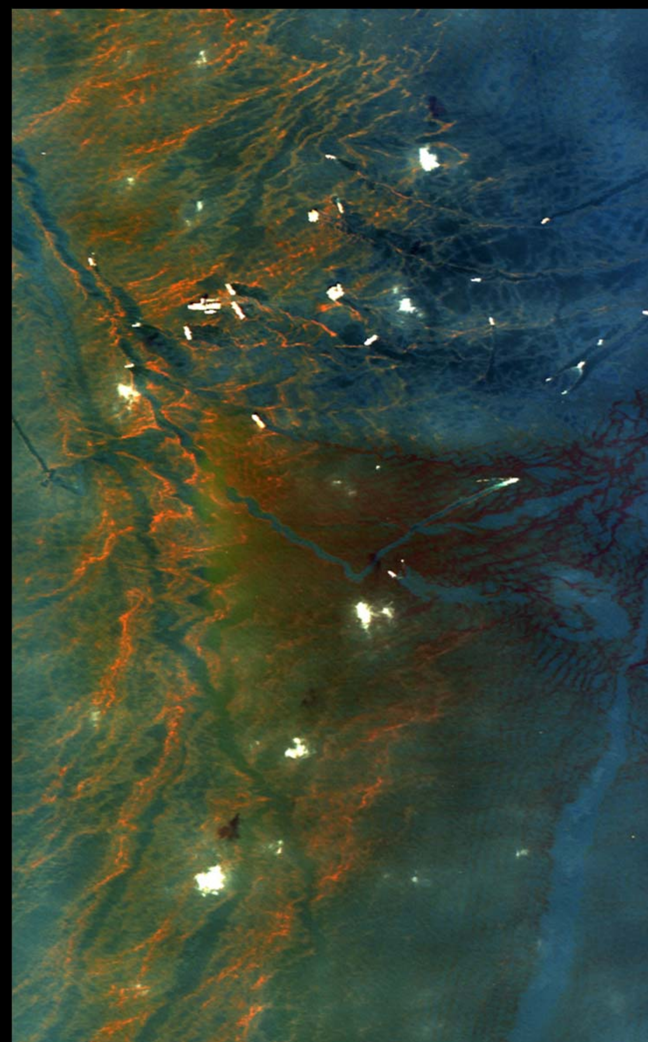


results from AVIRIS over the Gulf Oil Spill that show the spectroscopic signature of the crude oil carbon-hydrogen bond absorption features frared portion of the spectrum. This infrared spectral signature enables estimation of the location, type, and indicates aspects of the he oil on the water.

AVIRIS 17 May 2010, FL11

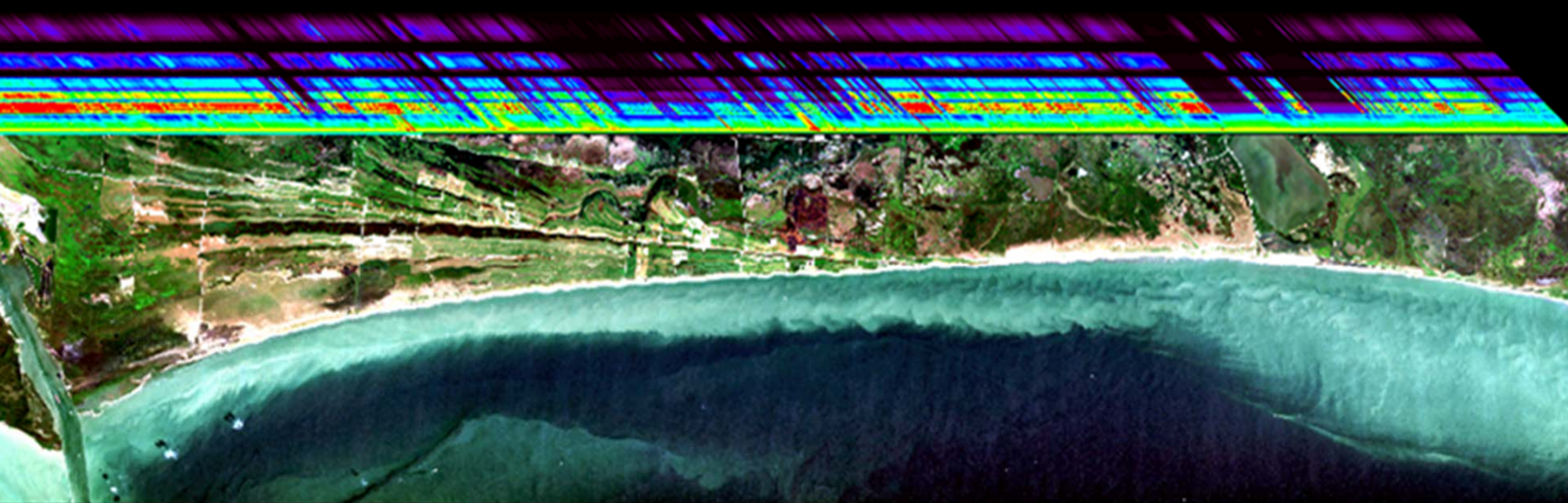
Blue Water

Spill Source Region



pectral signature of the oil measured in the infrared portion of the spectrum enables a new

Example AVIRIS Baseline Measurements Along the Gulf Coast

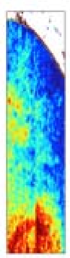


S imaging spectrometer measurements along the Gulf coast to measure the ecosystem
abitat characteristics and condition before possible oil contamination and impact. The
n is near Johnson's Bayou and along the Gulf Beach Highway, between Port Arthur, LA to
st and Cameron, LA to the East. The west corner includes part of the Texas Point National
e Refuge. The 224 wavelengths of light measured by AVIRIS from the visible to infrared
picted in the top and left panels. The spectrum measured for each point in the image will
ed to help assess the characteristics and conditions of the coastal ecosystems and

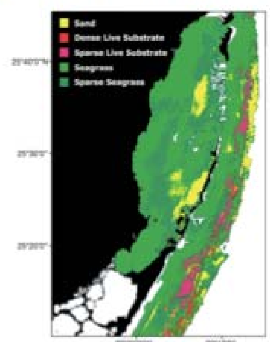
Ocean and Coastal Applications

- Products
  - Sea color (e.g. Chlorophyll-A, Fluorescent line height, Maximum Chlorophyll Index,…) (VSWIR)
  - Sea Surface Temperature (SST) (TIR)
- Heritage: MODIS, AVHRR, MERIS, SeaWifs, ASTER, Landsat ETM, VIIRS, Hyperion, CZCS, OCTS
- Applications
  - River plumes, reef studies, HAB, Oil spills, TSS, Chlorophyll, Carbon

False Color Level 1G Hyperion



FLH From Level 0.5R Hyperion [Chien et al 2009]



Reef classification map derived from Landsat ETM [Moses et al. 2008]

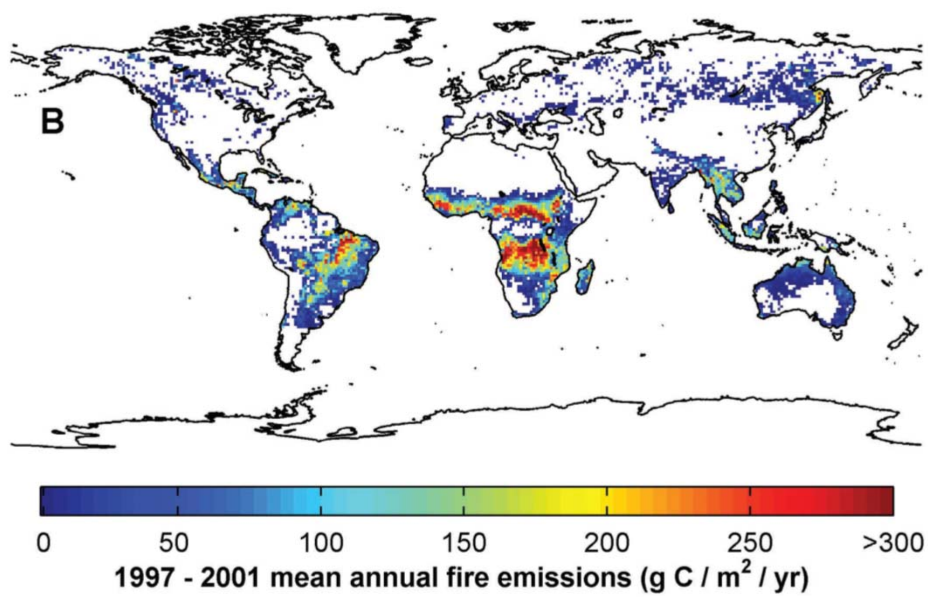
- Challenges
  - Atmospheric correction, cloud rejection (SST)
  - Case 2 waters (CDOM, TSS)

Carbon Release from Biomass Burning

bal Characterization of Fire Emission Sources

Biomass burning and fossil fuel emissions release ~10^{15} g of carbon (C) to the atmosphere each year. Biomass burning constitutes ~36% of all global C emissions.

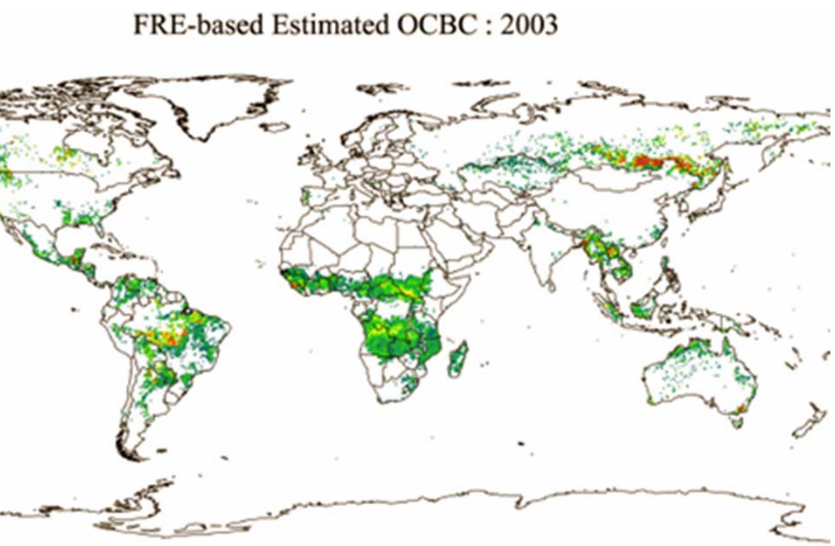
on	Fire emissions 1997-2001 average (10^{15}g C yr^{-1})
ral and northern South rica	0.27
hern South America	0.80
hern Africa	0.80
hern Africa	1.02
heast Asia	0.37
al (north of 38°N)	0.14
r	0.13
al	3.53

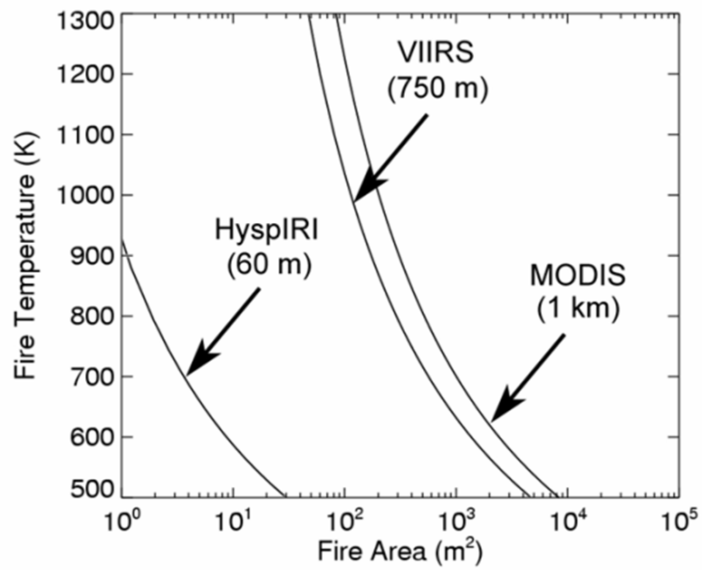


Van der Werf et al., 2004

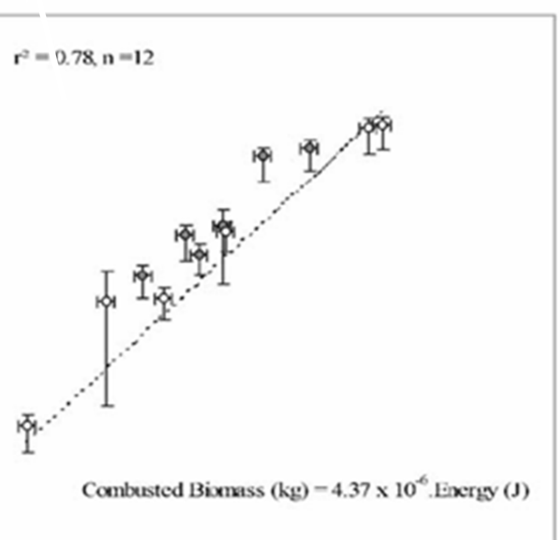
Carbon Release from Biomass Burning

Fire Radiative Energy





90% probability of detection; boreal forest; nadir view



Use Fire Radiative Energy to estimate combusted biomass: Need 3-5 um data

Ellicott et al 2009

Wooster et al 2002 and 2003

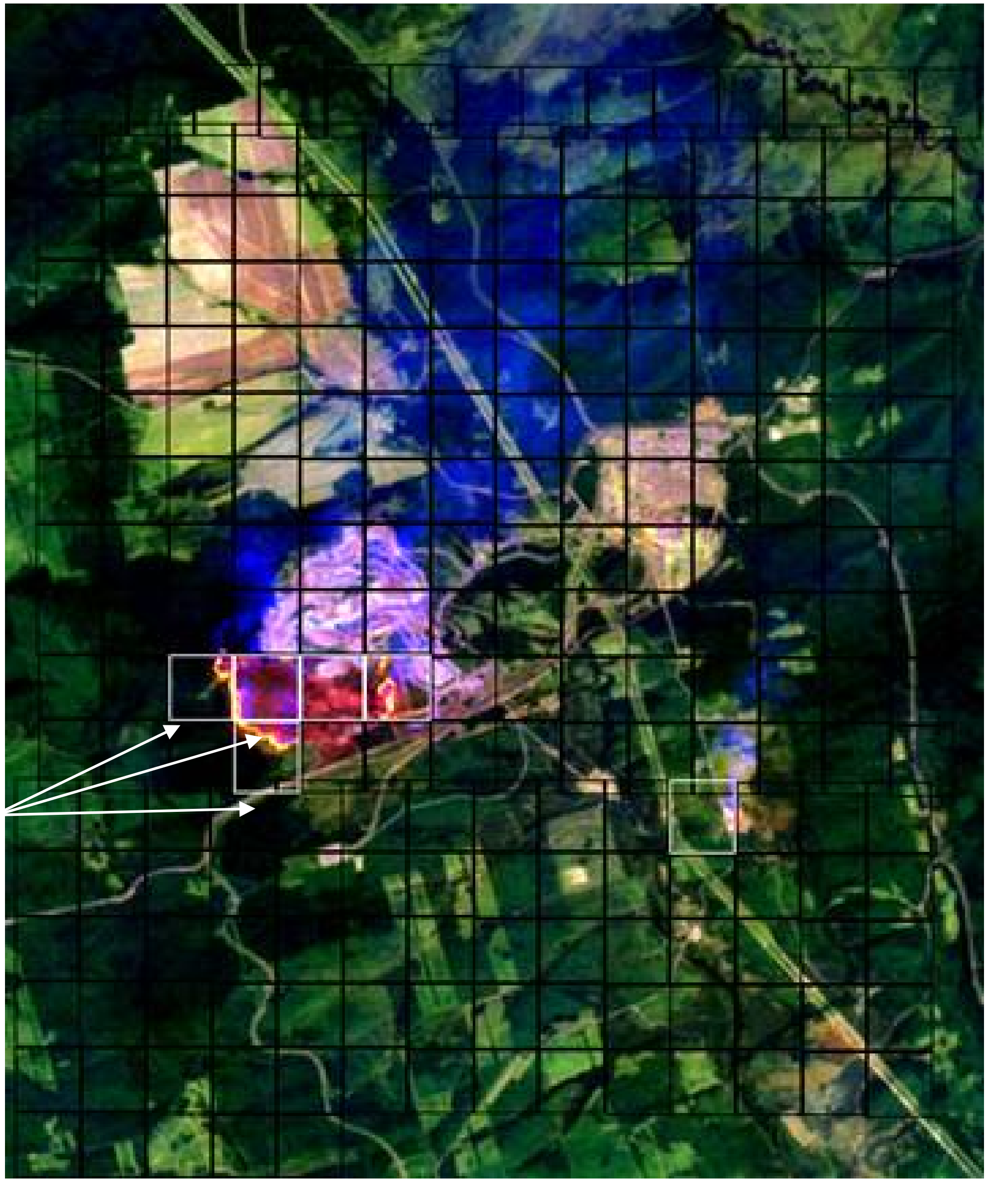
Carbon Release from Biomass Burning

How are global fire regimes changing? (patterns of fire occurrences, frequency, size, severity)

High resolution thermal instrument can distinguish between the forest and non-forest parts of the flaming front allowing the fire type, intensity, etc., to be determined which indicates fire regime.

White squares show fire pixels detected by MODIS. Insufficient information to detect fire type

MIR band provides radiant flux to estimate rate at which biomass combusted and instantaneous emission estimate



30 m ASTER scene with MODIS pixels superimposed (black squares)

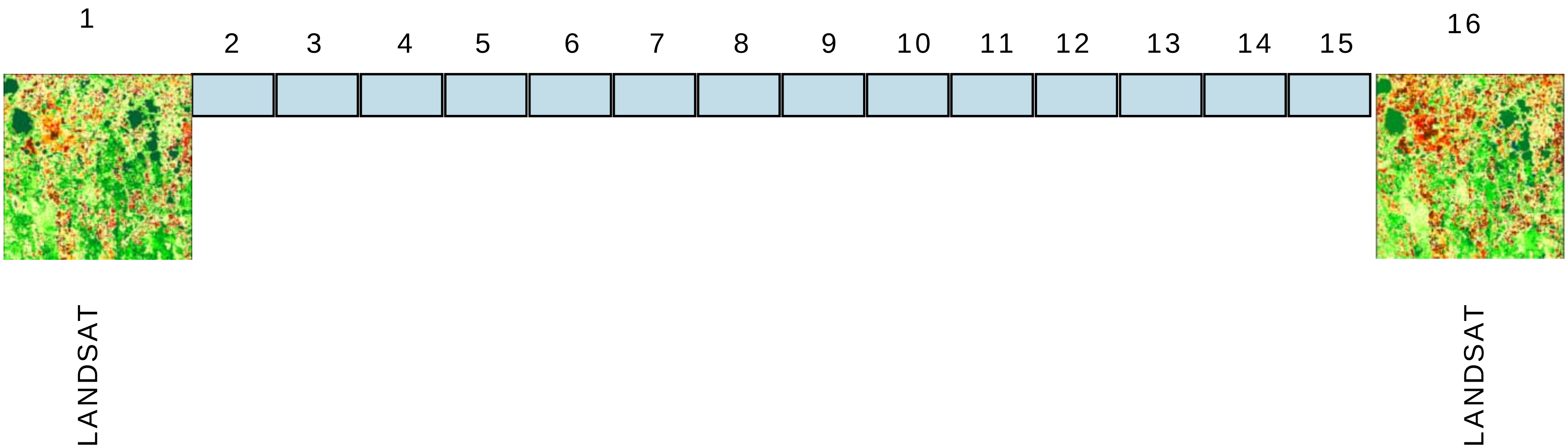
Central Siberia

30 May 2001

Evapotranspiration and Water Use and Availability

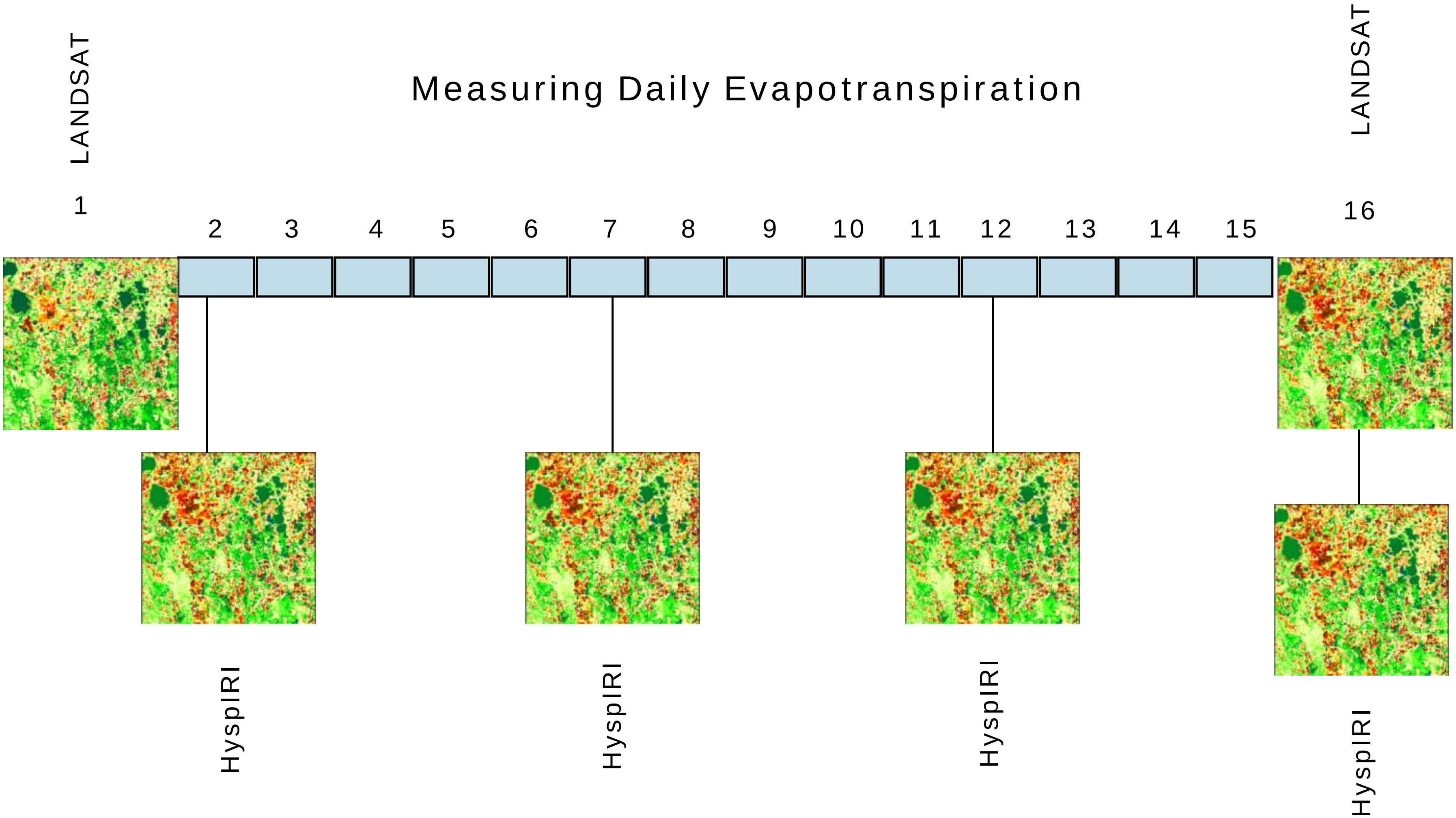
HIGH-RESOLUTION EVAPOTRANSPIRATION

Measuring Daily Evapotranspiration



Evapotranspiration and Water Use and Availability

HIGH-RESOLUTION EVAPOTRANSPIRATION



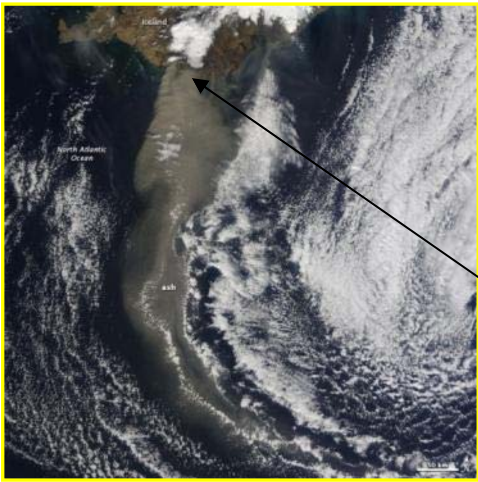
Gas and thermal anomalies, plume composition including SO_2 and ash content on weekly basis

Characterizing and Understanding Volcanic Eruptions

“Likewise, the Tier 2 **Hyperspectral Infrared Imager (HyspIRI)** mission would include measurements over a range of optical and infrared wavelengths useful for detecting volcanic eruptions, determining the ash content of volcanic plumes, and identifying the occurrence and effects of associated landslides.”

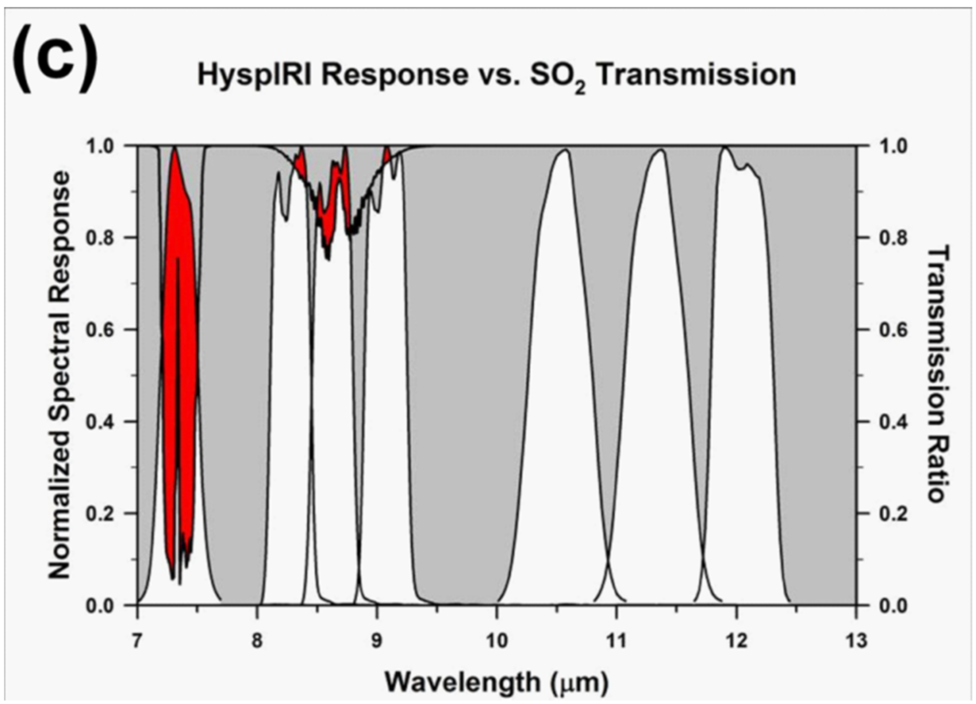
Source: Dr Jack Kaye, Presented to
Subcommittee on Space and Aeronautics
Committee on Science and Technology
United States House of Representatives,
May 5, 2010

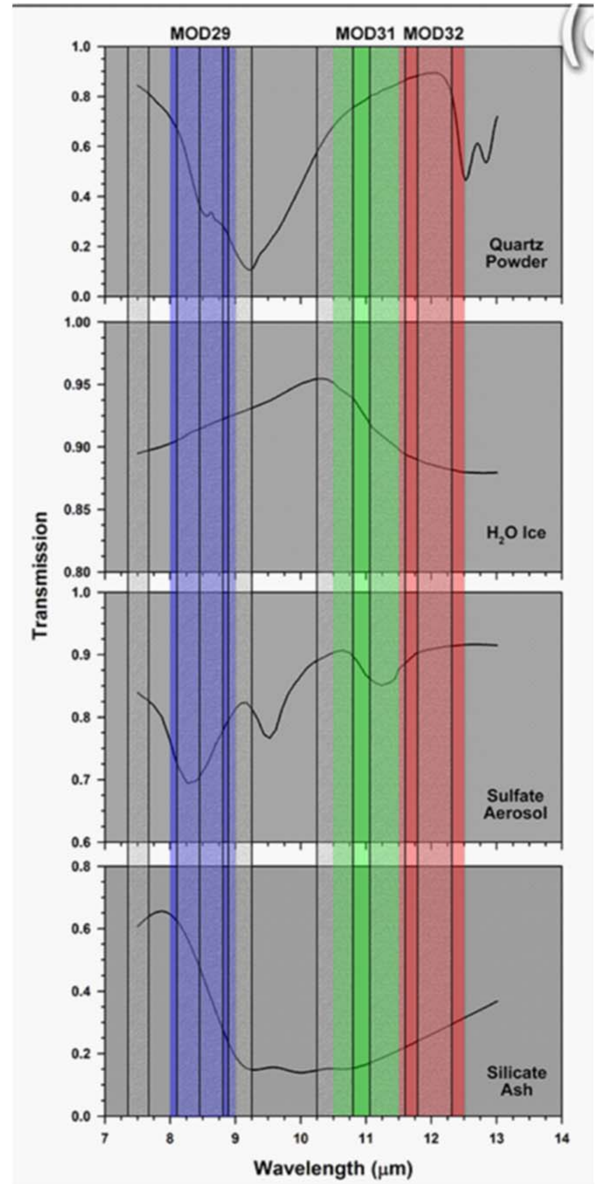
Characterizing and Understanding Volcanic Eruptions



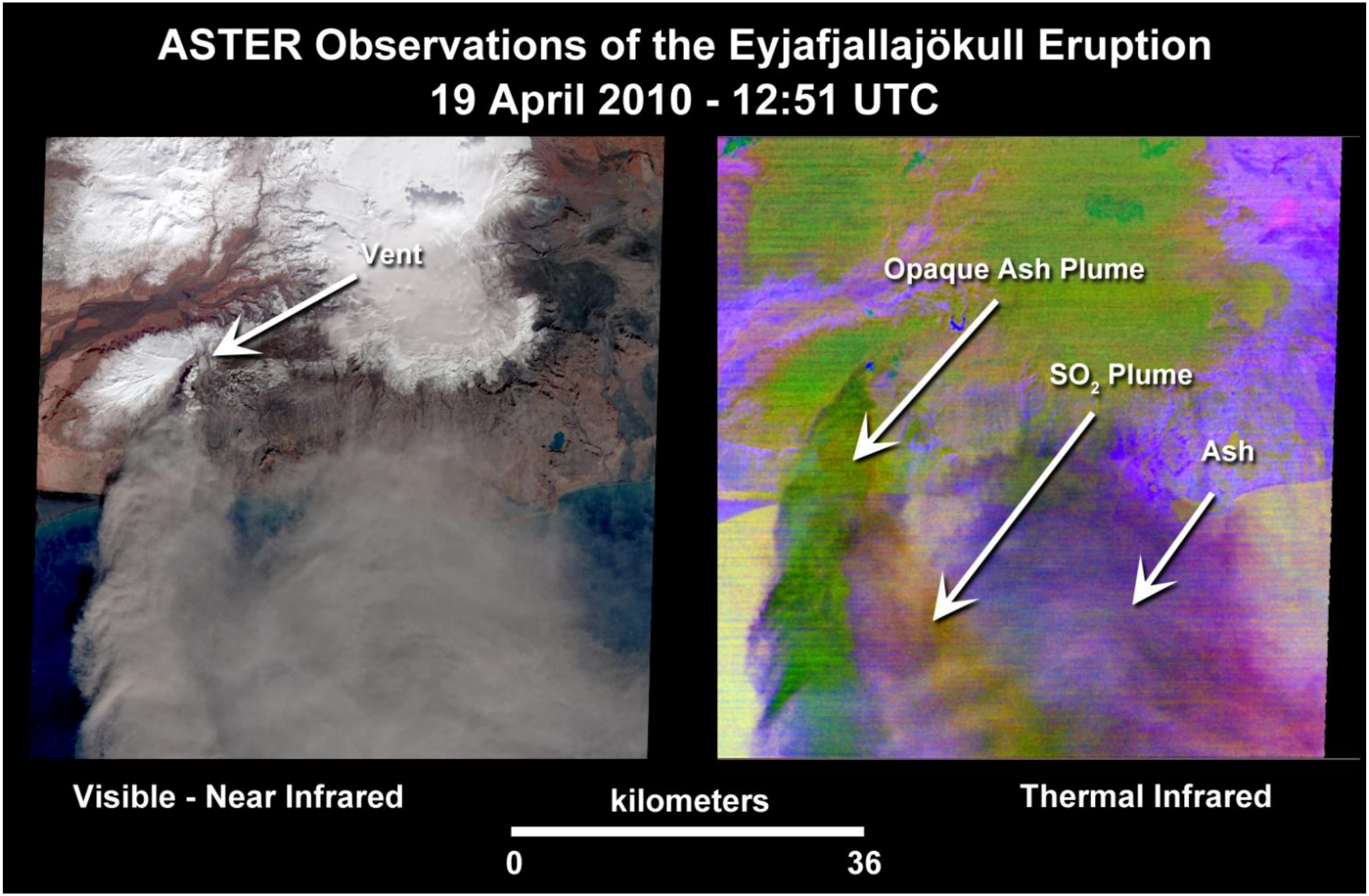
Eyjafjallajökull Iceland Volcano Eruption

April 19 2010 MODIS image of ash plume.

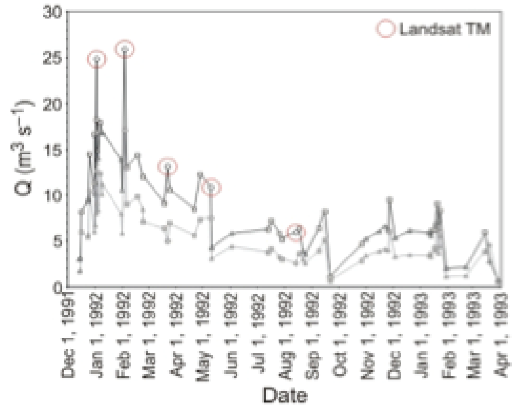


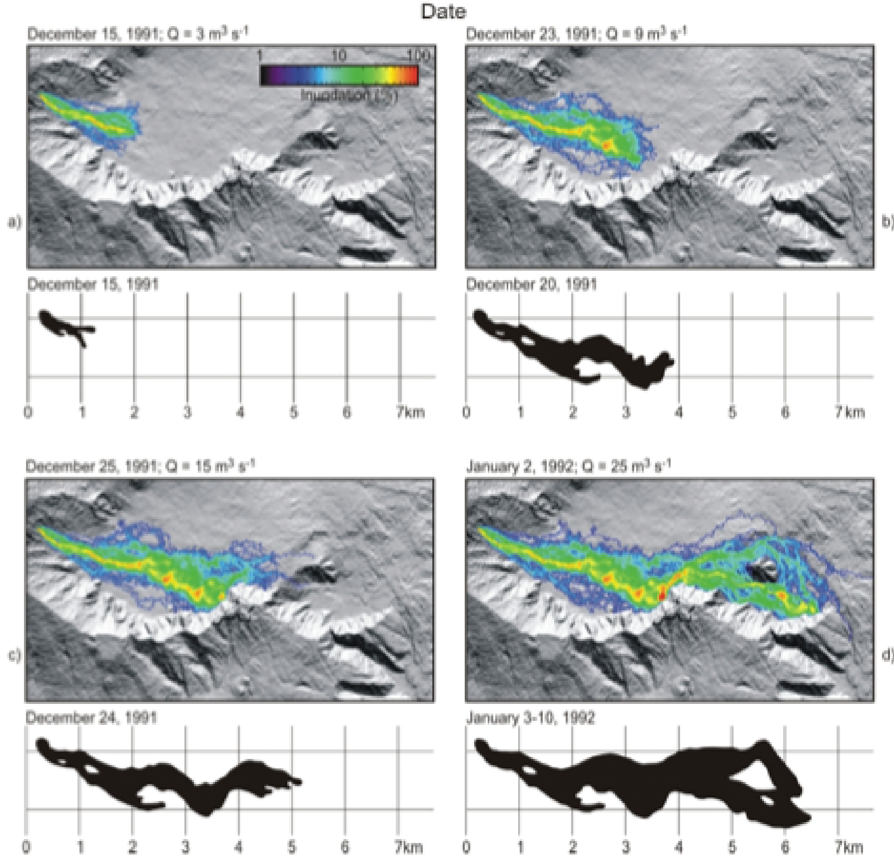


Characterizing and Understanding Volcanic Eruptions



TQ1b: What do changes in the rate of lava effusion tell us about the maximum lengths that lava flows can attain, and the likely duration of lava flow-forming eruptions?





Wright et al. (2008). *Geophysical Research Letters*, 35, L19307.

Science Issue:

- After lava composition, the volumetric effusion rate (modulated by surface cooling) determines how far a lava flow can extend from the vent before it solidifies. Effusion rates vary dramatically during eruptions, but can be quantified using infrared satellite data (top left; AVHRR, ATSR and TM data). By acquiring high spatial resolution TIR data, HyspIRI will allow us to determine effusion rates twice every five days during a lava flow forming eruption for any volcano on Earth. These data can be used to drive numerical models that predict the hazards that these flows will pose

Tools:

- Satellite observations from HyspIRI TIR; requires band at ~4 µm (saturation temperature of ~1600 K) with moderate-high spatial resolution (<100 m) for determining the area of active lava at any given time during as eruption and estimating the radiant energy flux from the flow surface.
- Pre-HyspIRI DEMs (e.g. SRTM) of all volcanoes likely to erupt basaltic lava flows
- Time-series of effusion rates determined using higher temporal resolution MODIS data for calibration.

Approach:

- Implement automatic analysis algorithms to flag anomalous thermal activity, determine active lava area and thermal flux, and, subsequently, a HyspIRI-derived effusion rate. Using this, a DEM, the vent location as recorded in the HyspIRI data, and a numerical lava flow model, generate simulations of likely lava flow paths for the given effusion rate. Autonomously update the hazard simulation as most recent HyspIRI derived effusion rates become available (lower left).

Results:

- A global, near-real-time lava flow hazard assessment tool, driven by HyspIRI TIR data.

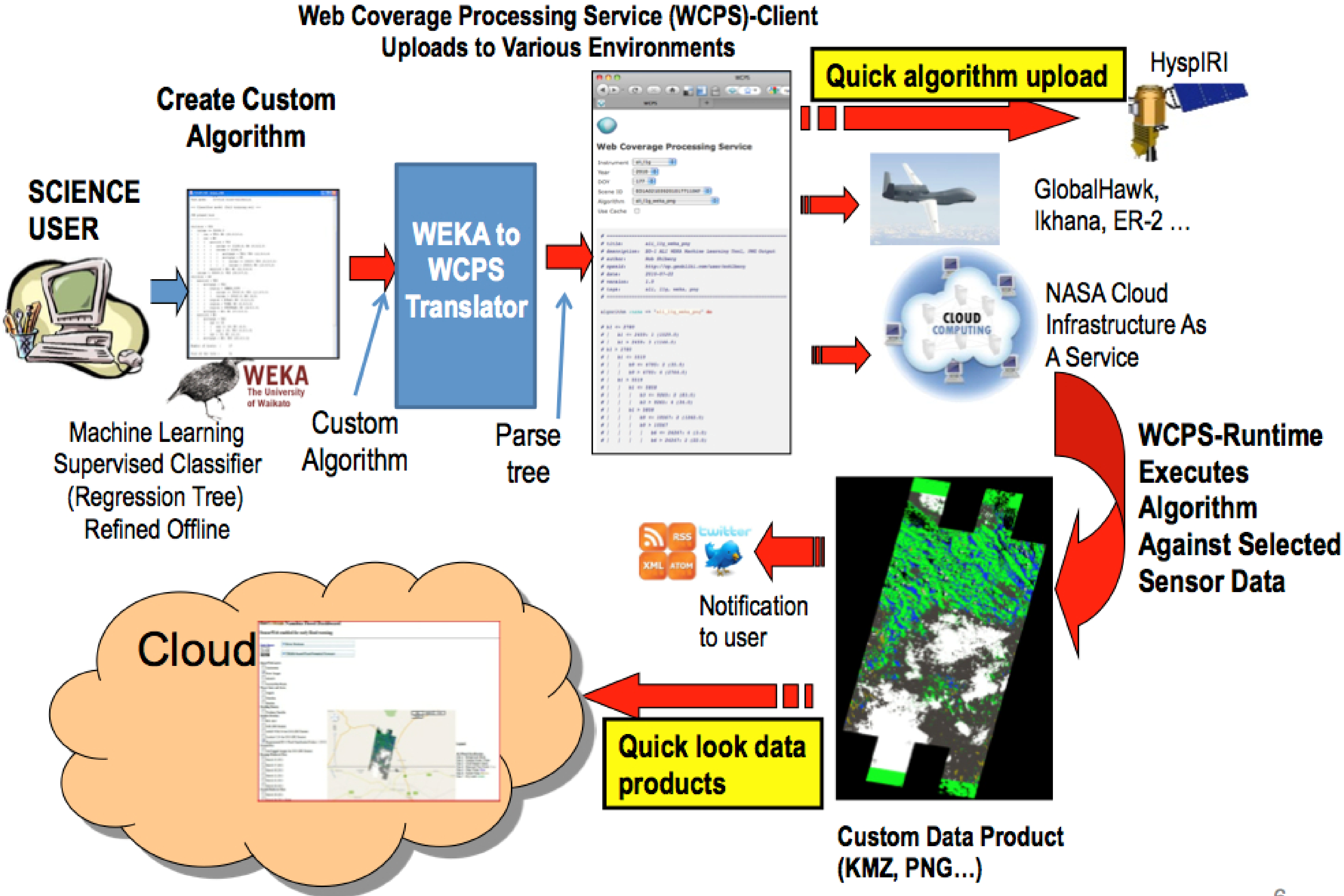
Prototyping Science As A Service with **Intelligent Payload Module**

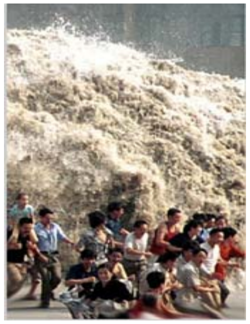
Daniel Mandl - NASA\GSFC

May 17, 2012

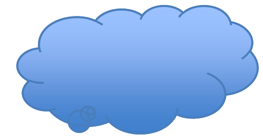
Experimental IPM Quick Load/Quick Look Ops Con

Enhanced Ops Con from Baseline IPM Ops Con





The New Data Products Paradigm

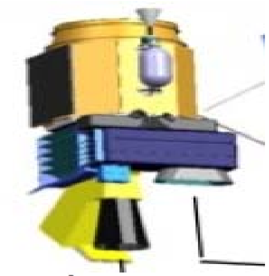


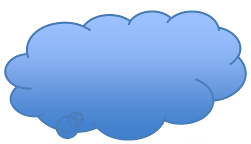
1. Tasking Request

- ✓ User requests low-latency imaging and specific product(s) by area and theme of interest.
- ✓ HyspIRI is one of the available SensorWeb assets.
- ✓ Request is submitted to satellite(s).
- ✓ One or more products are immediately downloaded as possible.
- ✓ User is notified upon product availability via data feed.
- ✓ User displays product on Google Earth or IPAD or desktop.

2. Cloud Processing

- ✓ User decides to [re-] process data from specific area or specific task request.
- ✓ User picks algorithm to execute against specific data set.
- ✓ User is notified when product is generated
- ✓ User selects product from data feed and display it on Google Earth





3. New Algorithm on the Cloud

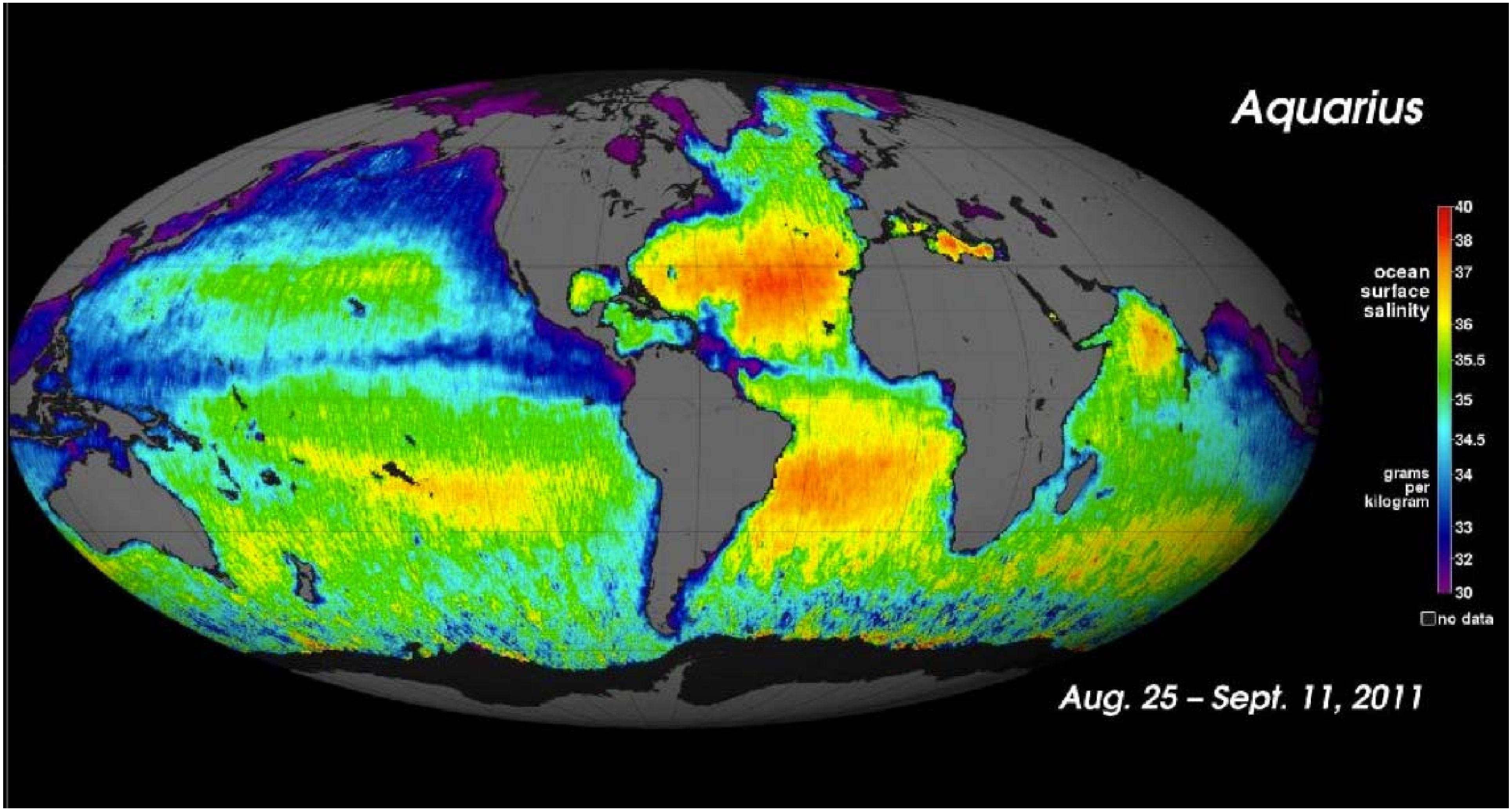
- ✓ User decides to customize an existing algorithm or create a new one.
- ✓ User could even use WEKA (Machine Learning Tool) and upload its output to WCPS.

3. New Algorithm Onboard

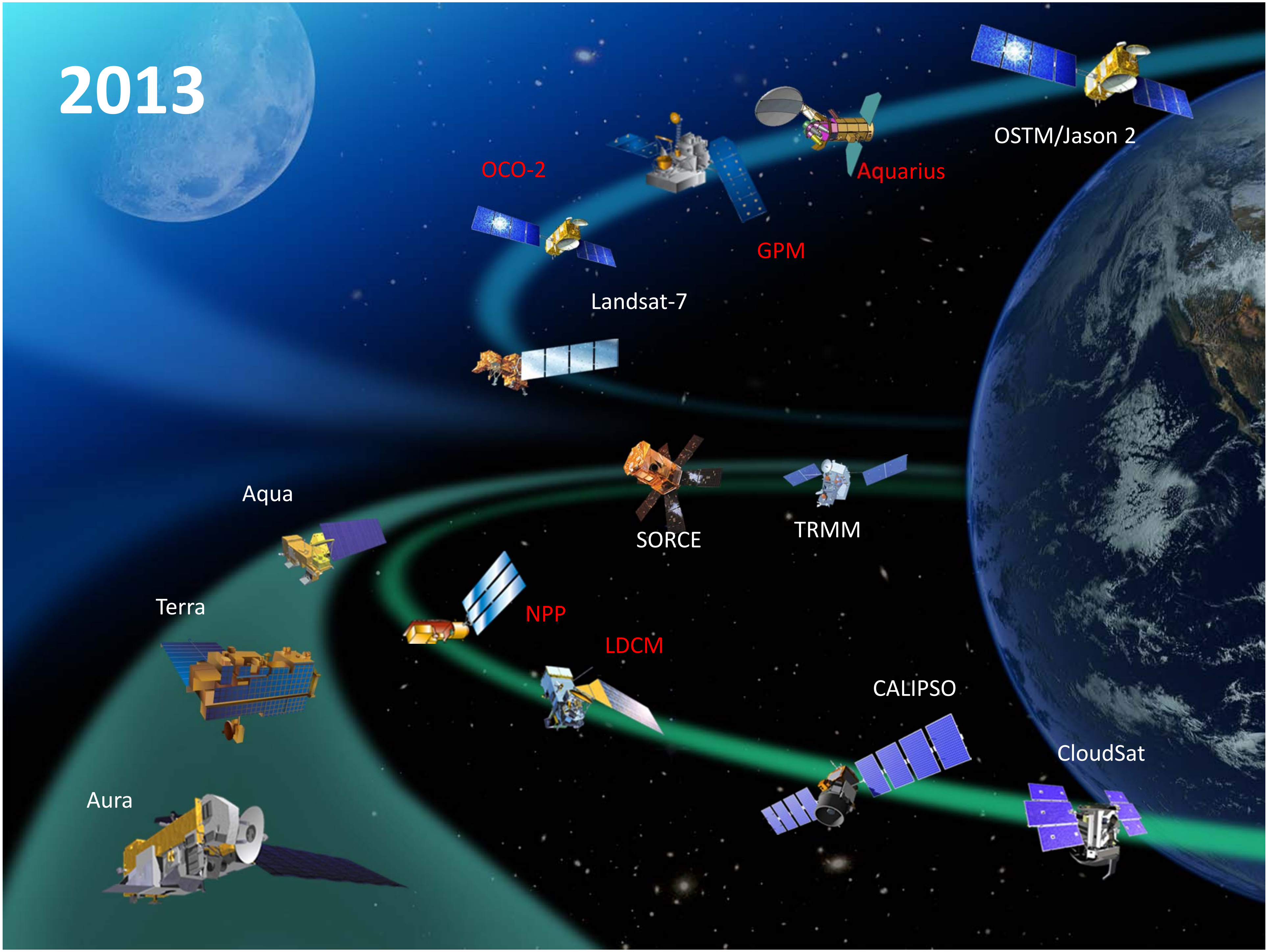
- ✓ User is satisfied with new algorithm.
- ✓ User submits algorithm for upload to HyspIRI
- ✓ Algorithm is now available for ad-hoc custom processing

HyspIRI Webpage

http://hyspiri.jpl.nasa.gov



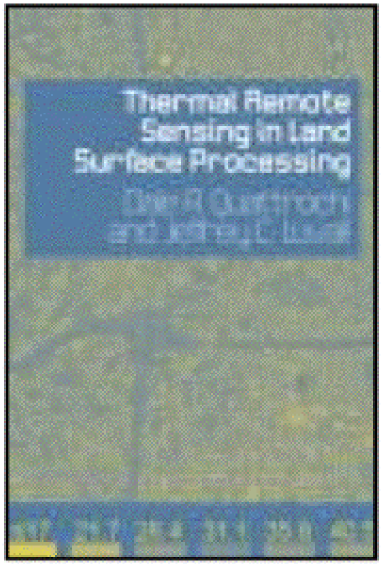
Aquarius instrument has produced its first global map of the salinity, or saltiness.


2013
OCO-2
GPM
Aquarius
OSTM/Jason 2
Landsat-7
Aqua
SORCE
TRMM
Terra
NPP
LDCM
CALIPSO
CloudSat
Aura


2014
OCO-2
Aquarius
OSTM/Jason 2
Landsat-7
Aqua
SORCE
NPP
LDCM
SMAP
GPM

Thermal Remote Sensing in Land Surface Processing

Dale A. Quattrochi, Jeffrey C. Luvall



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